INSTRUCTIONS

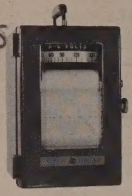
198 4557K10-001J
Supersedes 4557K10-001F

TYPE CH

STRIP-CHART RECORDERS

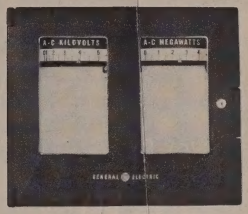
(THIS PUBLICATION FORMERLY IDENTIFIED AS GEH-1556)

Connections-
See Pages
11
12
36



PORTABLE

SWITCHBOARD



TWIN

DUPLEX

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These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

GENERAL ELECTRIC

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Portable, recording A.C. Voltmeter
6CH3VAL201 90-130V.A.C.
2 speed (3"/hr., 3"/min.) with 3 pos. switch (High-Off-Low)
Inking type Chart Carriage - Style 6

Received 23 Oct. 78 Plant Branch

SECTION I
INTRODUCTION

The recorders covered by this publication are strip-chart instruments, either ink and inkless type, which will measure, indicate, and record the value of an electrical quantity, or the value of a mechanical quantity which is converted to an electrical signal. These recorders provide a continuous, permanent record on a moving chart of the measured quantity with respect to time. They are available in the following types. All recorders except the Type CH-37 can be ink or inkless Type.

Type CH-1 recorder, switchboard, semiflush mounted.
Type CH-2 recorder, switchboard, surface mounted.
Type CH-3 recorder, portable type, single rated.
Type CH-4 recorder, portable type, multirated.
Type CH-6 recorder, portable type, for measuring AC and DC amps and volts.
Type CH-7 recorder, portable type, recording AC volt-ammeter with hook-on transformer. (Also see separate instruction book for CH-7 Hook-On Recording Volt-Ammeter.)
Type CH-11 recorder, portable type, for measuring watts and vars with hook-on transformer. (Also see separate instruction for CH-11 Wattmeter and Watt/Varmeter systems.)
Type CH-39 twin recorder, switchboard type, semiflush mounted.
Type CH-37 duplex recorder, switchboard type, semiflush mounted.

NOTE: The Type CH-9 recorder was replaced by the Type CH-11 recorder. Instructions in this manual referencing the Type CH-11 recorder apply to the Type CH-9 recorder also.

The Types CH-1, -2, and -3 recorders are used to record a single quantity and consist of a single measuring mechanism and a single chart carriage. The CH-4 is the same as CH-3 except multirated. In addition, the Type CH-7 recorder is used with a hi-voltage butyl-molded hook-on current transformer to measure a-c amperes or a-c volts. (For instructions concerning this recorder, refer to the instruction book shipped with the recorder.) The Type CH-11 measures watts and vars with same type hook-on current transformer. The Type CH-6 may be used to measure AC and DC volts, AC amperes, DC milliamps and DC millivolts; however, the number of terminals used in this unit is held to a minimum with the use of a range changing switch, located on the right-hand side of the case.

The Type CH-37 duplex recorder is ink-type only and is used to record two quantities on the same record roll; it consists of two measuring mechanisms and a single chart carriage mounted in a single-windowed case.

The Type CH-39 twin recorder is used to record two separate quantities on separate charts; it consists of two single CH-1 recorders contained in a double-windowed case. Normally, both chart carriages are driven by a single motor; however, if double-speed carriages are to be run higher than 7-1/2 inches per hour, both carriages are independently powered.

The inkless recorder uses a cam-operated stylus and inking-ribbon system to tap four marks per second on the chart. The recorder will operate approximately two months before the ribbon requires reversing.

The ink-type recorders use a sealed, transparent, plastic, nonspill, trouble-free, throw-away-type inkwell.

The Type CH chart-carriage assemblies are interchangeable, regardless of the style. Thus, the spring-driven chart carriage may be used in place of an electric motor-driven chart carriage in switchboard or portable models. (Refer to Section II for descriptions of main-drive units.) (Refer to Section VIII - Addendum, for obsolete and special styles of main-drive units).

RECEIVING

Immediately on receipt of the recorder, examine it for any damage that may have occurred in transit. Immediate examination is especially important if rough handling is evident. If damage is found, a damage claim should be filed immediately with the transportation company, and the nearest General Electric sales office should be notified promptly.

The following supplies are contained in a separate box and are shipped with each recorder:

INK TYPE

1 record roll (2 for Type CH-39)
1 recording pen and a pen cleaner (2 for each Type CH-37 and -39)
1 inkwell (2 for Type CH-37 and -39)
1 pen starter and a tube of chart-carriage lubricating oil
1 instruction book
2 door lock keys
1 clock winding crank (Style 23*) chart carriage only)

INKLESS TYPE

1 record roll (2 for Type CH-39)
1 pen stylus (2 for CH-39)
1 tube of chart-carriage lubricating oil
1 instruction book
2 door lock keys
1 clock winding crank (Style 23* chart carriage only)

*NOTE: The Style 23, 20-day spring clock chart drive supersedes the previous Style 5, 60-day spring clock chart drive.

Removal of Braces and Tapes

Recorder components which may be damaged during shipment are either taped or braced in position prior to shipment. The braces and/or tape should be removed as follows:

1. On all model recorders, remove the tape from the scale-support brackets, and tilt the scale up out of the way.

2. On all model recorders, remove the tape which is holding the pen-support assembly. This tape is fastened to the ink shield which is located in back of the scale assembly or the marker plate assembly for inkless type recorders.

3. On the Type CH-37 recorder only, remove the shipping screw which prevents the chart carriage from being swung out. This screw is located on the left-hand side of the recorder about half way down.

4. Remove the reroll spool at the bottom of the chart carriage and untape the keys. Remove the tape from the supply spool at the bottom of the chart carriage and behind the reroll spool.

HANDLING

Care should be taken to avoid jarring the recorder when it is being handled. Extreme shock may result in permanent injury to the jewel bearings in which the measuring mechanism is mounted.

STORAGE

If the recorder is to be placed in storage for an extended period, remove the inkwell and clean the pen as described in Section V, Maintenance. Repack the recorder in an upright position in the original carton and store it in an area free from corrosive fumes, high humidity, and extreme temperatures.

SECTION II
DESCRIPTION

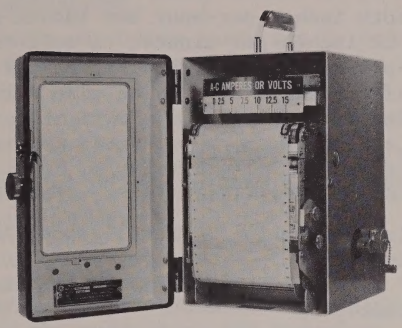


Fig 2-1. Portable Type CH Strip-Chart Recorder (Type CH-7)

The recorders consist of four main sub-assemblies. These are: the case, the door, measuring mechanism, and chart-carriage. (See Fig. 2-1.)

CASE ASSEMBLY

The cases used in these recorders are constructed of cast aluminum which provides a strong, lightweight, and rust-proof enclosure for the instrument mechanism. The switchboard models have a non-glare black finish, and the portable models have a light-gray hammertone finish. A glass window(s) is provided for external viewing of the chart and scale. The gasketed door provides a tight seal to exclude dust and moisture. The locks on all recorder doors can be opened by one key.

The switchboard models, which may be either surface or semiflush mounted, contain a fluorescent lamp and lamp switch. The portable models have rubber feet and a leatherette carrying handle. The door on portable models may be removed by lifting it up and off the hinges.

CHART CARRIAGE

The chart-carriage assembly accurately records the value of the measured quantity, with respect to time, on a moving chart.

In all single recorders and the Type CH-39 twin recorder, the chart-carriage assembly is held by four removable mounting screws at the rear of the case and may be removed from the case, if necessary. In the Type CH-37 duplex recorder the chart carriage is hinged, and may be swung out and lifted off for removal.

The chart carriages, which are designated by style numbers, consist of the following:

Style 2: An electric-drive unit which provides a single-speed in the range from 3/4 to 12 inches-per-hour. When used in a Type CH-39 twin recorder, the maximum recommended speed is 6 inches per hour. The maximum recommended speed in a Type CH-37 duplex recorder is 12 inches per hour. A self-contained switch marked ON/OFF is wired to provide "on" chart-speed control in the "on" position. (See Fig. 5-3.)

Style 6: A double-speed electric-drive unit provides speeds in both inches-per-minute and inches-per-hour in the range from 3/4 inch-per-hour to 12 inches per minute. When used in a Type CH-39 twin recorder, the maximum recommended speed is 3 inches per minute. The maximum recommended speed in a Type CH-37 duplex recorder is 6 inches per minute. A self-contained switch marked HI/OFF/LO is wired to provide inches-per-hour, off, and inches-per-minute chart-speed control.

Style 7: A double speed electric drive unit similar to the style 6 except it is factory wired for remote switching with user furnished double-pole, 3-position switch rated not less than 1 ampere at 125 volts a-c. A self-contained ON/OFF switch is provided to activate the chart carriage.

Style 23: (Replaces Style 5) A double-speed hand-wound spring-clock drive unit which provides drives of both inches-per-hour and inches-per-minute in the range from 3/4 inch-per-hour to 12 inches-per-minute. A self-contained lever marked HI/OFF/LO provides inches-per-minute, off, and inches-per-hour chart-speed control. This 20 day clock is a self-contained unit which also serves as the power source for the reroll drive unit. (See Fig. 5-6.)

Styles 3, 4, and 5: Refer to Section VIII.

The chart-carriage assembly is made up of the following main subassemblies:

Side-and-back-plate Assembly
Timing-drum Assembly
Writing Table
Supply-spool Assembly
Reroll-spool Assembly
Cover-and-plate Assembly
Drive-unit Assemblies

SIDE-AND-BACK-PLATE ASSEMBLY -- This is the main framework of the chart-carriage assembly for attaching the chart carriage to the recorder case. All other parts of the chart-carriage assembly are mounted on this frame. NOTE: This assembly is performed in precision fixtures and care should be taken not to disturb its alignment.

TIMING-DRUM ASSEMBLY -- receives its power from a motor through gearing, drives the chart by means of sprocket pins contained in both ends of the drum. The sprockets engage holes in the chart and drive the chart at a predetermined rate of speed.

WRITING TABLE -- provides a smooth surface for the pen or stylus to record the value of the measured quantity on the moving chart.

SUPPLY-SPOOL ASSEMBLY -- located in the lower section of the chart-carriage assembly in back of the reroll spool. The supply spool holds a roll of chart paper which is 110 feet in length. A paper-supply indicator, located on the lower left-hand side of the chart-carriage assembly, indicates the amount of paper left on the supply spool. In addition, on single chart carriages the supply indicator maintains sufficient back tension on the paper to provide a smooth and even paper feed. The spring which loads the indicator should not be disturbed.

REROLL-SPOOL ASSEMBLY -- winds the chart paper -- by means of a motor and gearing -- and also keeps tension on the paper so that an accurate recording may be made.

COVER-AND-PLATE ASSEMBLY -- provides protection for the drive units against dust or physical damage, and in addition serves as a guide for the chart paper.

DRIVE UNIT ASSEMBLIES -- Two power sources and associated gear trains are used. These are: a main-drive unit which furnishes power to the timing-drum assembly, and a reroll-drive unit which furnishes power to the reroll-spool assembly. The handwound clock drive has a self-contained reroll-drive mechanism.

Main-drive Units -- Four types of main-drive units are available. Three of these are of the electric-drive type; the remaining is a hand-wound spring-clock type. (NOTE: The spring-clock type drive unit is not used in Type CH-37 duplex recorders.)

Reroll-drive Unit -- consists of the induction motor and gear-train assembly, or the hand-wound spring clock. The reroll-drive unit provides the power to the reroll spool which winds and keeps tension on the chart paper. The electric reroll-drive unit is a complete subassembly which may be removed from the chart carriage as a unit. (See Fig. 5-5.)

Speed Change Gears -- All main-drive units power the timing-drum assembly through associated fixed-and change-gear-train assemblies. The change gears consist of four gears, (two for the clock) mounted on the left-hand side of the chart-carriage mechanism. These gears, which are color coded for ease of identification, may be changed to obtain different gear ratios and thus provide various chart-speed combinations.

Four additional pairs of change gears can be made available for each recorder. These gears, when not in use, are stored on the right-hand side of the chart-carriage mechanism.

The change-gear combination used, together with the style of main-drive unit determines the various chart-speed combinations obtainable. The desired chart speed may be obtained by referring to the nameplate on the chart carriage which also contains the information necessary for changing the gear ratios and for positioning the switch lever.

The spring-clock reroll-drive obtains its power from the main clock spring through a separate gear train contained within the clock mechanism. This gear train is independent of the main-drive and therefore is not regulated by the escapement in the clock mechanism.

MEASURING MECHANISM

The following table lists the three types of measuring mechanisms used in these recorders:

TABLE II-1
TYPES OF MEASURING MECHANISMS

QUANTITY TO BE MEASURED	TYPE OF MEASURING MECHANISM
All d-c and expanded-scale a-c volts or frequency	Alnico V permanent-magnet moving-coil
*All a-c (except current and expanded scales)	Electrodynamic (electrodynamometer)
*A-c amperes	Iron-vane

*A-c volts or amps may also be measured with a rectifier type unit using a permanent-magnet moving-coil type of mechanism.

The measuring-mechanism assembly is a self-contained unit which may be easily removed from the recorder for servicing. In addition to the moving system, each assembly contains either an inking or an inkless type recording system.

The inking type contains an ink shield, scale-support brackets, inkwell clamps, pen saddle. The ink shield is a black rectangular plastic plate which completely covers the moving system. The shield serves as the inkwell support and, in addition, it minimizes the possibility of ink and dirt falling into the moving system. The inkwell clamps are fastened to the ink shield by means of a hinge assembly. These clamps snap onto the ink container and hold it in place.

The inkless type system contains a recording unit assembly in place of pen and inkwell. The recording unit assembly consists of a stylus, left-and-right-hand motor, pushrod, cams, inking ribbon and brackets.

The scale-support brackets hold and position the scale assembly. These brackets allow the scale to be tilted up out of the way in order to facilitate servicing the pen and inkwell.

The pen saddle is rigidly attached to the armature shaft. The saddle holds the pen and positions it on the chart paper in accordance with the angle of rotation of the armature shaft.

Recorders designed to measure a-c quantities are equipped with a magnetic shield. This shield minimizes the possibility of erroneous indications caused by stray magnetic fields.

The armature of each measuring mechanism is mounted on a pivoted shaft. This shaft rotates on bearings contained at each end. The upper bearing is of the bronze-sleeve type and the lower bearing is of the sapphire ringstone-endstone type. The ringstone-endstone bearing is protected from shock by means of a helical spring contained in the lower-bearing assembly. This spring limits the danger of damaging the pivot and jewel assembly (lower bearing) if the recorder is subjected to jarring or shock.

A resistor-plate assembly is used in recorders which are designed to measure a-c or d-c volts, and a-c watts. This assembly is a combination of fixed and adjustable resistors which are mounted on an aluminum support plate contained in the bottom of the recorder case. The resistors, which are temperature compensated, are used to limit the current in the potential circuit of the measuring mechanism.

Internal impedors are also used for frequency recorders. The mounting is the same as a resistor plate described above.

SECTION III

INSTALLATION

LOCATION

The recorders should be installed in an area free from high humidity, corrosive fumes, and excessive vibrations. In addition, they should be kept at a reasonable distance from transformers and conductors carrying high currents which produce stray magnetic fields.

MOUNTING

The outline, mounting, and panel cutout dimensions of the recorders are shown in Fig. 3-1 through 3-8. All drilling and hammering on the panel should be completed before mounting the recorder.

If the shipping braces and/or tape were not removed when the recorder was received, remove them as described in Section I, Receiving.

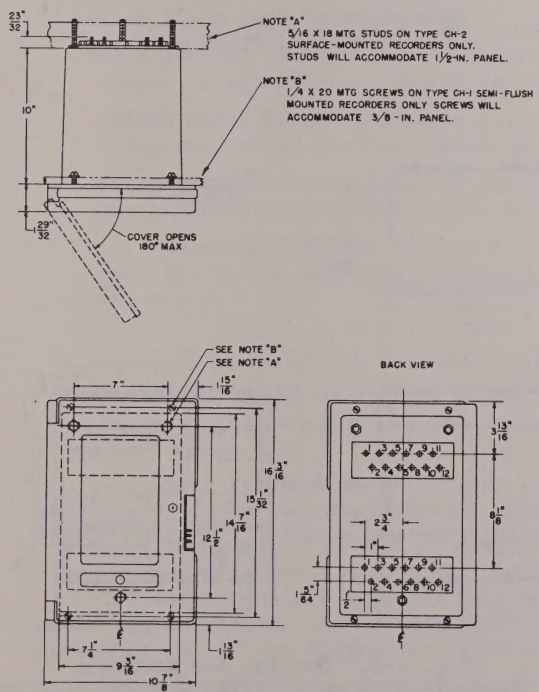

NOTE "A"
5/16 X 18 MTG STUDS ON TYPE CH-2 SURFACE-MOUNTED RECORDERS ONLY. STUDS WILL ACCOMMODATE 1½-IN. PANEL.
NOTE "B"
1/4 X 20 MTG SCREWS ON TYPE CH-1 SEMI-FLUSH MOUNTED RECORDERS ONLY SCREWS WILL ACCOMMODATE 3/8 - IN. PANEL.
COVER OPENS 180° MAX
SEE NOTE "B"
SEE NOTE "A"
BACK VIEW

Fig. 3-1. Outline and mounting dimensions of Type CH-1 and CH-2 switchboard models (surface and semi-flush mounting)

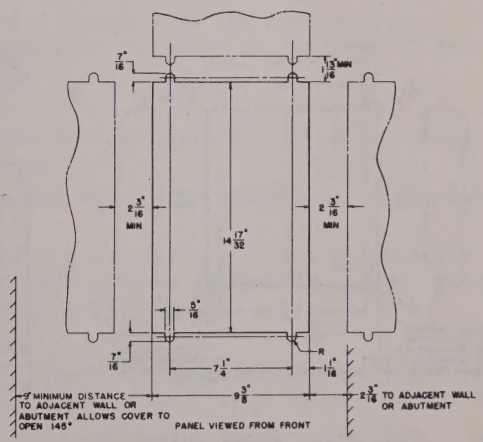

MINIMUM DISTANCE TO ADJACENT WALL OR ABUTMENT ALLOWS COVER TO OPEN 145°
PANEL VIEWED FROM FRONT
TO ADJACENT WALL OR ABUTMENT

Fig. 3-2. Panel cutout dimensions for semi-flush mounting Type CH-1 models

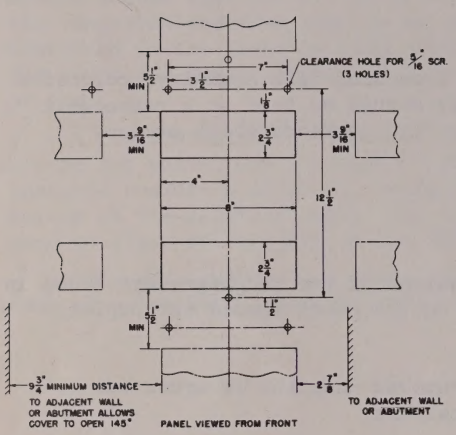


Fig. 3-3. Panel cutout dimensions for surface mounting Type CH-2 models

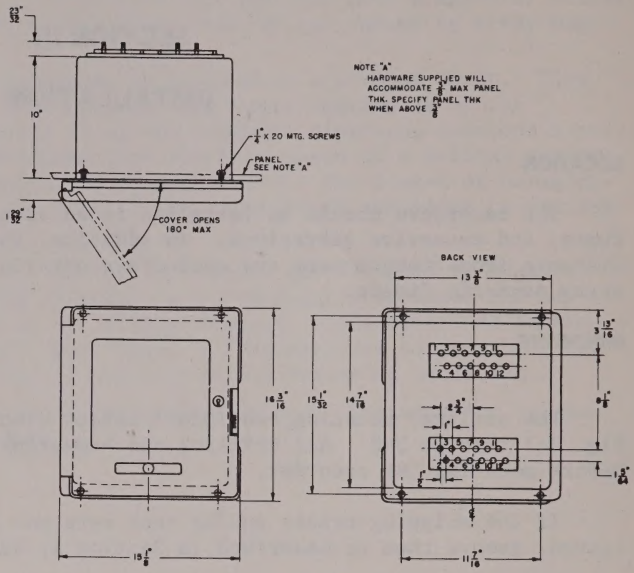


Fig. 3-4. Outline and mounting dimensions of Type CH-37 duplex recorder (semi-flush mounting)

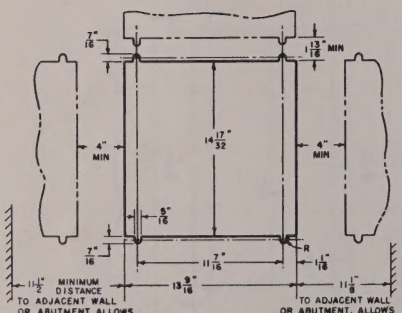


Fig. 3-5. Panel cutout dimensions for semi-flush mounting Type CH-37 models

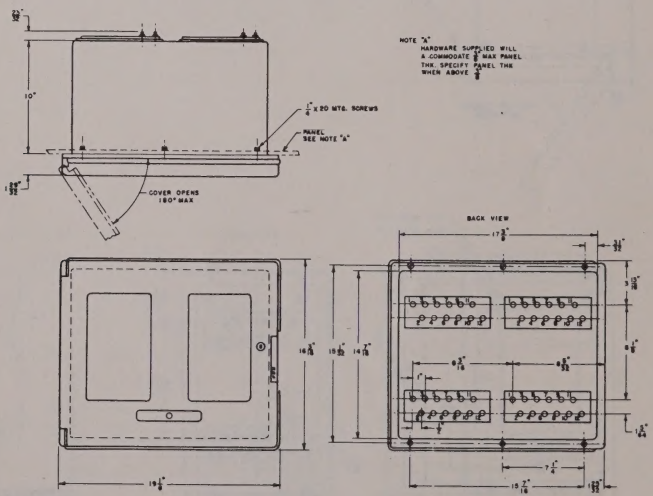


Fig. 3-6. Outline and mounting dimensions of Type CH-39 twin recorder (semi-flush mounting)

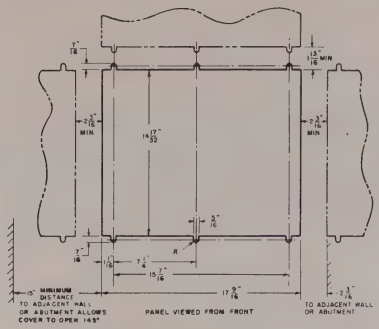


Fig. 3-7. Panel cutout dimensions for semi-flush mounting Type CH-39 models

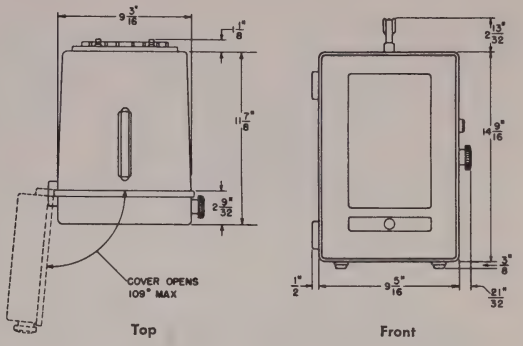


Fig. 3-8. Outline dimensions of all portable models

IMPORTANT: The dimensions in Fig. 3-2, 3-3, 3-5, and 3-7 labeled "To Adjacent Wall or Abutment", are minimum dimensions and must be maintained. It is permissible to exceed, but not to decrease this dimension.

EXTERNAL CONNECTIONS

SAFETY PRECAUTIONS

GROUNDING OF RECORDER CASES

It is essential that the practice of grounding the recorder cases, as a part of the installation procedure, be followed so as to prevent damage to equipment or injury to personnel while handling the recorder.

SWITCH BOARD TYPES -- Connect all panel mounted recorder cases to ground using any one of the case mounting studs as the connector.

PORTABLE TYPES -- Connect all portable recorder cases to ground using the ground stud provided on the side of the case.

On earlier models that do not have a ground stud the user can connect the ground wire to a terminal board mounting screw at the rear of the CH case.

* * *

Connections to all CH recorders are made through upper and lower terminal blocks located on the back of the recorder case.

Refer to the nameplate on the recorder for the proper operating voltage and frequency.

The upper terminal block is used for making connections to the chart-drive motors and to the lamp (switchboard models only) and any accessories. Connections to the chart-drive motors are as shown in Fig. 3-9 and 3-10.

The lower terminal block is used on all recorders for making connections to the measuring mechanism. Refer to Section VII, External Connection Diagrams. Make sure that the proper diagram is selected.

Connect tachometer recorders to their tachometer generator as shown in external-connection diagram Fig. 7-18.

IMPORTANT: External connections for the Type CH-37 duplex recorder are furnished separately with each recorder according to its application.

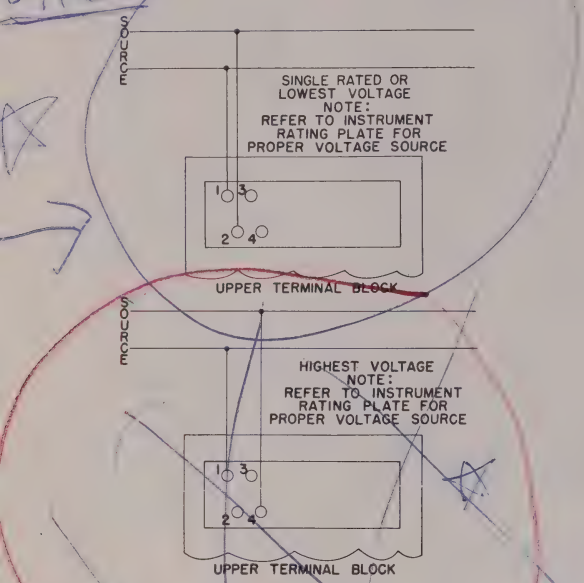

SOURCE
SINGLE RATED OR LOWEST VOLTAGE NOTE: REFER TO INSTRUMENT RATING PLATE FOR PROPER VOLTAGE SOURCE
1 3
2 4
UPPER TERMINAL BLOCK
SOURCE
HIGHEST VOLTAGE NOTE: REFER TO INSTRUMENT RATING PLATE FOR PROPER VOLTAGE SOURCE
1 3
2 4
UPPER TERMINAL BLOCK

Fig. 3-9. External connections to chart-drive motors for Styles 2 and 6 chart carriages

NOTE:
If indicating lamps are to be used for "HI" and "LO" speed indication, a 3P3T switch must be used. The lamps must be independently connected from the DPDT switch shown.

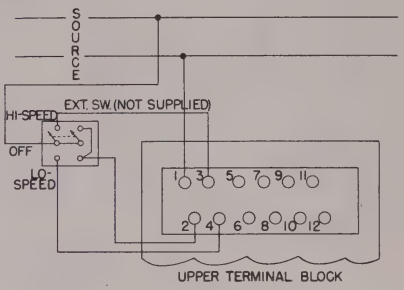


Fig. 3-10. External connections to chart-drive motors for Style 7 chart carriages.

TABLE III-1

EXTERNAL CONNECTIONS
TO UPPER TERMINAL BLOCK (ACCESSORIES)

ACCESSORY	TERMINAL CONNECTIONS
Lamp*	5 and 6
Heater	7 and 8
Right-Hand Marker Pen	9 and 10
Left-Hand Marker Pen	11 and 12
Motors	See Fig. 3-9 and 3-10

*For 240V, the lamp is common connected with the chart carriage (T1 and T2).

SECTION IV

OPERATION

PRELIMINARY OPERATION

After the proper connections have been completed, perform the operations described below.

SELECTION AND INSTALLATION OF CHANGE GEARS

This section applies only to recorders which are supplied with extra sets of change gears.

The chart-carriage nameplate in each recorder contains the information necessary for selecting the proper change-gear combination for the chart speed desired. Refer to Table IV-1 for the approximate length of time a record roll will last at each chart speed.

Extra sets of change gears are stored on the right-hand side of the chart-carriage mechanism. After determining the change-gear combination which will provide the desired speed, install the gears (if the gears already in position are not the proper ones) in their proper positions as follows:

1. Remove the knurled screw (11, Fig. 4-1a) and pull out the change-gear plate.

2. Remove the knurled nut and remove the correct gears from the change-gear plate.

3. Remove the incorrect change gears from the rate gear shafts by removing the knurled nuts (12, Fig. 4-1a).

4. Install the proper gears on the change-gear shafts, making sure that the slot in the gear is facing in towards the recorder. Care should be taken to insure that the keyway on the gear shaft slips into the slot in the gear.

5. Replace the knurled nuts (removed in Step 3) and tighten them securely.

6. Store the extra gears on the change-gear plate assembly, and then replace the assembly on the side of the chart-carriage mechanism. Replace the knurled screw (removed in Step 1).

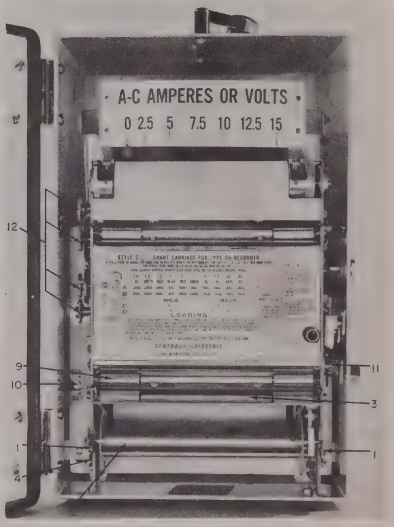


Fig. 4-1a

INSTALLATION OF RECORD ROLL

The following steps, along with the corresponding photographs, describe the proper method for installing a roll of chart paper in the recorder.

NOTE: The following steps are also applicable to the Type CH-37 duplex recorder, except that the chart carriage and record roll are wider than shown.

TABLE IV-1
RECORDER SPEED VS. RECORD ROLL REPLACEMENT
(Chart length 110 ft.).

Basic Speed Inches Per Hour	Approximate Time Record Roll will Last	Recommended Replacement Schedule △	Basic Speed Inches Per Minute	Approximate Time Record Roll will Last
1/4	218 days		1/4	88 hours
1/3	162 days		1/3	65 hours
1/2	107 days	3 mos.	1/2	44 hours
3/4*	70 days	2 mos.	3/4*	29 hours
1	52 days		1	22 hours
1-1/2*	34 days	1 mo.	1-1/2*	14-1/2 hours
2	26 days		2	11 hours
3*	17 days	2 wks.	3*	7-1/4 hours
4	12 days		4	5-1/2 hours
6*	8 days	1 wk.	6*	3-1/2 hours
7-1/2	6 days		7-1/2	2-3/4 hours
9	5 days		9	2-1/4 hours
10	4 days		10	2 hours
12*	4 days		12*	1-3/4 hours
15	3 days		15	1-1/2 hours

*Standard speeds

△ The Style 23 hand-wound spring-clock, will run 20 days on one windup, or at 3 inches per hour or more will last the length of the Chart. The obsolete style 5 spring clock would run 60 days on one windup.

1. Press down the latches (1, Fig. 4-1a) on each end of the reroll spool (2, Fig. 4-1a) and then lift the spool out.

2. Grasp the supply-roll spool (3, Fig. 4-1a) and pull it up and out of the recorder.

NOTE: The indentation (9, Fig. 4-1a) is for a roller required on a Style 23 chart carriage only.

3. Remove the used record roll (if one is in the recorder) from the reroll spool, by first pulling out the flange on the end opposite the drive gear and then sliding the roll off the spool. Replace the flange on the spool (Fig. 4-1b) making sure that the flange is pushed all the way into the spool.

4. Hold a new record roll with the elongated holes to the right and then insert the supply roll spool into the right-hand side of the record roll. Care should be taken not to "telescope" the record roll when inserting the supply-roll spool.

5. Tear the end of the chart paper into a "V" (Fig. 4-1c).

6. Snap the new record roll into position while simultaneously holding down the paper-supply indicator (4, Fig. 4-1c) and holding up the drag plate (5, Fig. 4-1c). (On the Type CH-37 duplex recorder, it is not necessary to hold down the paper-supply indicator.)

7. Pass the end of the chart paper above the drag plate (5, Fig. 4-1c) and

Fig. 4-1b

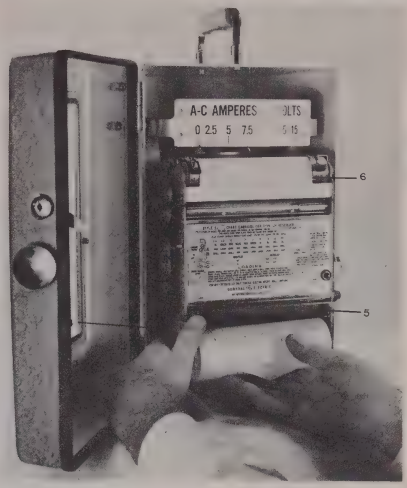


Fig. 4-1c

Fig. 4-1d

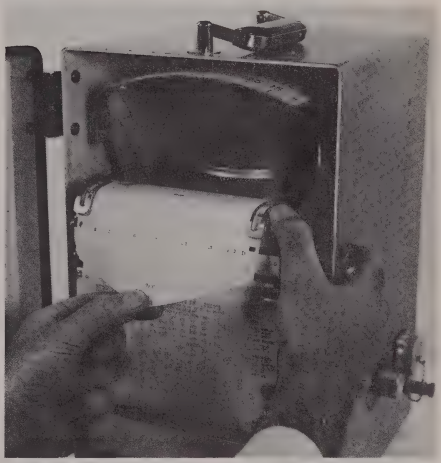


Fig. 4-1e

between the roller (7, Fig. 4-1d) and writing table (8, Fig. 4-1d), until it appears behind the writing table as shown in Fig. 4-1d. Slide the chart paper under the paper guides.

8. Pull through approximately 16 inches of paper, by turning knurled end of timing drum with thumb (Fig. 4-1e and 4-1f) being careful not to tear the paper on the sprockets in the timing drum.

9. Hold the reroll spool so that the gear is on the right-hand side, and then insert the end of the chart paper into the slot in the spool (Fig. 4-1f).

10. Wind several turns of the chart paper onto the reroll spool (record side out).

11. Hold up the drag plate (5, Fig. 4-1g) and snap the reroll spool into position. Then, lower the drag plate so that it rests on the reroll spool flange and check the reroll-spool drive gear to make sure that the gear is properly engaged.

NOTE: Style 23 spring-clock-driven chart carriages, have an additional roller directly above the drag plate; thread the paper in front of this roller.

12. Pull a few inches of chart paper off the reroll spool (Fig. 4-1h) to unlatch the spool and, while allowing the paper to rewind slowly, make sure that the sprockets in the timing drum engage the holes in the paper.

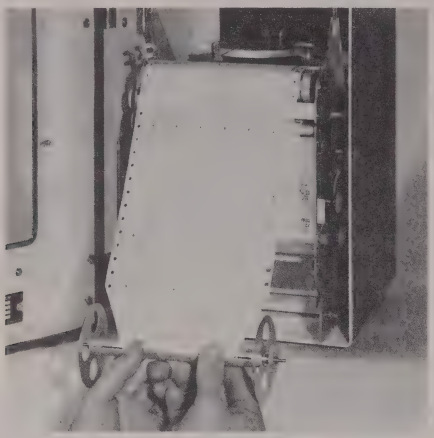


Fig. 4-1f

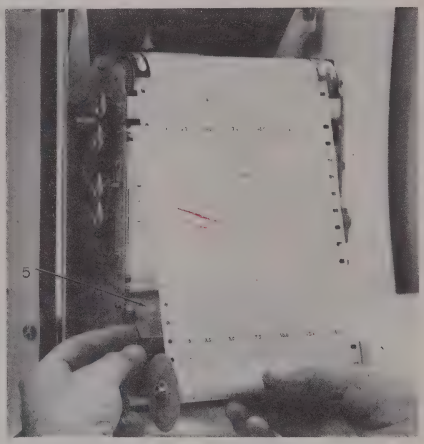


Fig. 4-1g

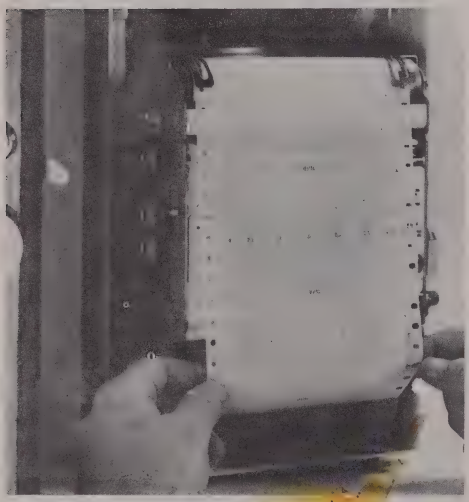


Fig. 4-1h

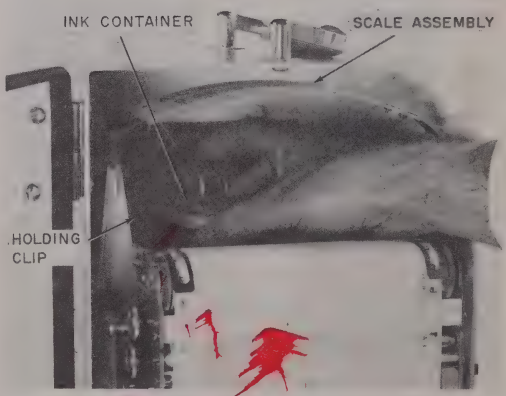


Fig. 4-2.

NOTE: If the reroll spool will not rewind the paper, it may be due to the reroll drive spring being run down. This will make it necessary to either energize the chart-driven motor or wind the spring clock, depending on whether the recorder chart carriage is electric-motor driven or spring-clock driven.

13. If necessary, wind the spring clock (Style 23 chart carriage only).

CHART TEAR-OFF

Slash the record roll with a pencil or fingernail along the groove on the

lower edge of the writing table (8, Fig. 4-1d). Remove the lower portion of the chart and re-thread chart per Steps 3 through 13 under Installation of Record Roll.

INSTALLATION OF INKWELL AND PEN

The proper method for installing an inkwell and pen is as follows:

1. Tilt the scale assembly up out of the way.

2. If an inkwell and pen are already in the recorder, remove them as follows:
   a. Carefully unsnap the pen from the spring clip. Immediately upon removal, tip the pen upside down to prevent the ink from flowing out.
   b. Unsnap the two clips which hold the inkwell in place and then carefully lift the inkwell out of the recorder.

3. Place the new inkwell in the recorder (the side of the inkwell which has the tape covering the hole should be in the back of the case). Make sure that it is properly seated. (See Fig. 4-2.)

4. Snap the two holding clips onto the groove in the inkwell cover.

5. Remove the tape (if present) covering the hole in the inkwell.

6. Carefully place the stem of the pen into the ink container and then push the pen down into the spring clips on the pen saddle. A click will be "felt" on both sides as the pen is pushed into the clips.

NOTE: The tip of the pen will not rest on the chart paper if the pen is not full of ink. This condition will be present in a pen which is being placed into operation for the first time. This condition will also be present if ink has been spilled from a pen which has already been in operation. To fill the pen and start it inking, refer to the section entitled "Inking the Pen".

The pen has been balanced so that when filled with ink it will rest on the paper and write properly with a minimum of pressure. If, for any reason, it becomes necessary to change the pen balance, it can be done by readjusting the balance weights which are provided on the pen. Excessive pen pressure can cause the pen to become "sticky", while insufficient pen pressure can cause skips in the recorded trace.

NOTE: When the pen is properly balanced, skips in the recorded trace are normal when the measured quantity is suddenly varied a large amount, such as from zero to almost full scale.

INKING THE PEN

The following procedure may only be completed after the pen has been installed in the recorder. To ink the pen, proceed as follows:

1. Squeeze the pen-starter bulb.

2. Keep the bulb collapsed and then carefully insert the tip of the pen into the hole in the tip of the pen starter.

3. Release the pressure on the bulb slowly while watching the transparent tip of the pen starter.

4. When the ink is visible in the tip, carefully lift the tip of the pen without further lessening the hand pressure on the pen-starter bulb.

5. Place the tip of the pen on the chart paper.

6. Rinse the pen starter out and allow to dry before placing it in its container.

Inks

The ink furnished with the recorder is specifically designed to produce a record which provides maximum contrast for ease in reading, and good chart reproduction. Red, black, brown, and green inks are available in three drying speeds to facilitate satisfactory recording over a wide range of temperature and chart speeds. Table IV-4 lists these inks, their drying speeds, and their operating temperatures. Reference should be made to the catalog numbers listed when ordering ink. If color is not specified when ordering, red ink will be supplied as this is the standard color.

INSTALLATION OF RIBBON (Inkless-type Recorder only, Fig. 4-3)

To install the ribbon on inkless-type recorders, proceed as follows:

1. Mount the supply spool on the right-hand spindle so that the spool rotates in a counterclockwise direction.

2. Thread the ribbon in the direction of the arrows shown in Fig. 4-3. Make sure that the ribbon passes around the two guides (1) and that it passes over and then under the guide brackets (2) on the end of the unit.

3. Roll the ribbon onto the take-up spool as it rotates in counterclockwise direction.

4. Mount the take-up spool on the left-hand spindle.

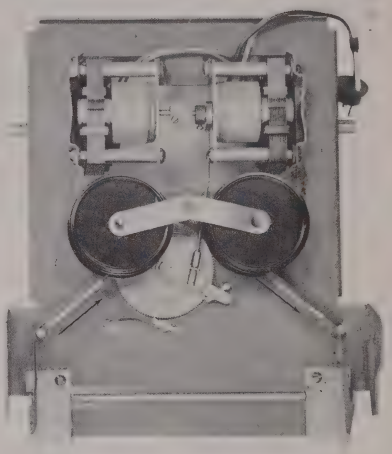


Fig. 4-3. Inkless recording unit for Type CH Strip-chart recorders.

TABLE IV-2
INKS

Color	Fast Drying (Fast Chart Speed)	Medium Drying (Medium Chart Speed)	Slow Drying (Slow Chart Speed)
	32°F to 95°F	20°F to 104°F	-5°F to 120°F
Red Black	4496K10G700 4496K10G703	4496K10G701 4496K10G704	4496K10G702 4496K10G705

ZERO ADJUSTMENT

To position the pen on zero, rotate the zero-adjusting screw (10, Fig. 4-1a). (On the Type CH-37 duplex recorder, two zero-adjusting screws are provided. The top screw positions the left-hand pen and the bottom screw positions the right-hand pen.) The zero-adjusting screw(s) can also be used to position the pen at any desired point on the scale. This feature makes it possible to change, for example, a zero-left recorder (provided it has a linear scale distribution) to a zero-center recorder. Since this does not change the full-scale value of the recorder, the electrical value from the "new" zero to each end of the scale will be half of the original full-scale value. For example, a 0-1 ma. full-scale recorder would be changed to a 0.5-0.5 ma. recorder.

Tachometer Recorder Calibration

The tachometer recorder is calibrated for use with a specific tachometer generator. The recorder is calibrated for full-scale indication at the voltage marked FSV on the nameplate.

A rheostat is provided which permits an adjustment of 10 percent (in either direction) of the full-scale voltage. This rheostat may be used to compensate for variations in generator voltage, lead resistance, aging of the rectifier, or to make small "on the job" adjustments.

To adjust the rheostat, loosen the locking nut on the rheostat shaft, insert a small screwdriver in the slot, and turn until the instrument indicates the generator speed as measured by an accurate tachometer, or other speed-measuring means. Tighten the locking nut to prevent any accidental change in the setting. Re-check the recorder calibration after tightening the lock nut.

OPERATING LIMITS

OVERLOADS

Current -- Momentary overloads of d-c and a-c ammeters of 3 or 4 times the full-scale value (or higher) may cause the pen tip to splash ink on the inside wall of the recorder case; an occasional momentary overload up to 10 times the full-scale recorder value will not cause damage to the recorder measuring mechanism, however, repeated overloads should be avoided.

Voltage -- The recorders are designed to withstand the following high-potential tests:

1. 3000 volts RMS 60 Hz for 1 minute between the measuring circuit and ground.
2. 1500 volts RMS 60 Hz for 1 minute between accessory circuits and ground.
3. 1500 volts RMS 60 Hz for 1 minute between the two elements of a polyphase wattmeter.
4. 1500 volts RMS 60 Hz for 1 minute between the measuring circuits and ground for units containing conventional diodes.
5. 1200 volts RMS 60 Hz for 1 minute between the measuring circuit and ground for units containing Zener diodes.

TEMPERATURE RANGE

The temperature range within which the recorder will operate satisfactorily is governed by the type of ink used. (See Table IV-2 for temperature limits.) The inkless recorders will operate satisfactorily within the temperature range of -10°F to +120°F. The low temperature range may be extended by adding heaters. Refer to Section VI, ACCESSORIES.

POWER SUPPLY (DRIVE MOTORS)

Line voltage variations should not exceed 10 percent of the recorder's drive motors rated voltage.

NOTE: If the recorder is operated at the minimum temperature and voltage limits simultaneously, the maximum chart-paper speed obtainable under this extreme condition is half of that normally recommended.

OPERATING PROCEDURE

After the steps in the INSTALLATION and PRELIMINARY OPERATION sections have been completed, proceed as follows:

1. Check the spring clock to see if it is fully wound (Style 23, chart carriage only), or energize the chart-drive motors (Styles 2, 6, and 7). The spring clock must be wound when installing a new record roll, or every 20 days if the recorder is operated at speeds of 3 inches-per-hour or less.

2. Energize the chart carriage by placing the HI/OFF/LO lever or switch in the desired position.

3. Rotate the timing drum forward, using the knurled portion, until the proper time markings (if used) on the chart paper line up with the tip of the pen.

4. To turn the lamp on or off in the switchboard models, press the push-button switch in the upper right-hand corner of the recorder. Starting is automatic.

NOTE: On older models the push button must be held in until the ends of the lamp glow. Then release the switch. To turn the lamp off, pull the switch-button outwards.

The operation of the recorder is now automatic, except for periodic replacement of record rolls and ink.

SCALE READINGS — MULTIRATED RECORDERS

Multirated recorders are furnished with record rolls which are usually marked for direct reading at the lowest range. To obtain a reading on a given range, the scale reading should be multiplied by the ratio of the rating being used to the scale. If a current or potential transformer is used (multirated recorders - not transformer rated), multiply the scale reading by the ratio of the transformer used. If both current and potential transformers are used (for wattmeters), multiply the scale reading by the product of the two transformer ratios.

Examples:

Voltmeters and Ammeters

If a 150/300/600-volt voltmeter with a 150-volt scale is used at a 300-volt rating, multiply the voltage reading by 300/150 or 2.

If a 5/10-ampere ammeter with a 5-ampere scale is used at a 10-ampere rating, multiply the current reading by 10/5 or 2.

If a 300:5 current transformer is used with an ammeter, multiply the current reading by 300/5 or 60.

Wattmeters

If a 120/240-volt, 5/10-ampere wattmeter with a one kilowatt scale is used at a 240-volt, 10-ampere rating, multiply the scale reading by 240/120 x 10/5 or 4.

If a 10:1 current transformer and a 5:1 potential transformer are used with a wattmeter, multiply the reading by 10/1 x 5/1 or 50.

Universal Wattmeters

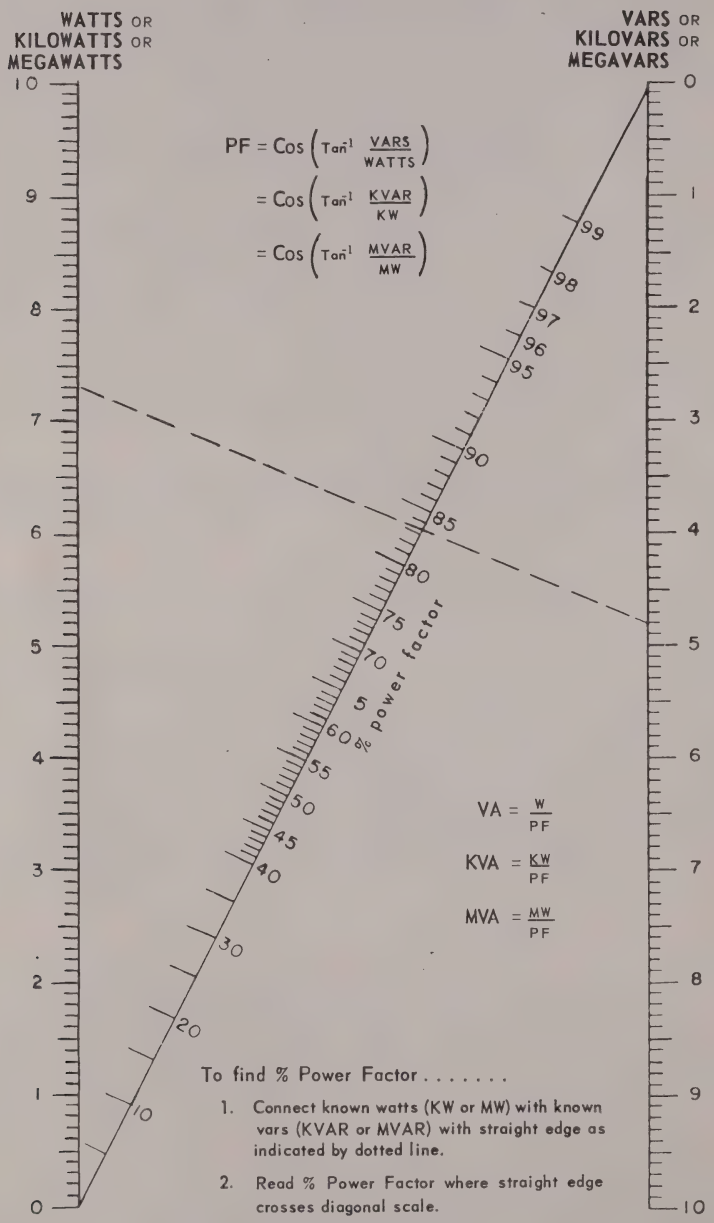
If current and potential transformers are used, multiply scale reading by the product of the two transformer ratios. For example, if a 120-volt, 5/10-ampere, universal wattmeter with a one-kilowatt scale is used on 3-phase, 4-wire with a 14,400:120 potential transformer and a 300:5 current transformer, multiply the scale reading by 2 (from Table IV-5) and then multiply the product obtained by 14,400/120 x 300/5 or 7200.

TABLE IV-3

120, 5/10 AMPERE UNIVERSAL
WATTMETER WITH A 1 KW SCALE

Type of Circuit	Rating Used Volts	Rating Used Amperes	Multiply Scale Reading By
Single-phase	120	5	1/2
	120	10	1
3-phase, 3-wire	120	5	1
	120	10	2
3-phase, 4-wire	120	5	2

CONVERSION OF WATTS AND VARS TO % POWER FACTOR


WATTS OR KILOWATTS OR MEGAWATTS
VARS OR KILOVARS OR MEGAVARS
PF = Cos (Tan⁻¹ VARS/WATTS)
= Cos (Tan⁻¹ KVAR/KW)
= Cos (Tan⁻¹ MVAR/MW)
% power factor
VA = W/PF
KVA = KW/PF
MVA = MW/PF
To find % Power Factor . . . . . .
1. Connect known watts (KW or MW) with known vars (KVAR or MVAR) with straight edge as indicated by dotted line.
2. Read % Power Factor where straight edge crosses diagonal scale.

SECTION V

MAINTENANCE

INSPECTION

Inspect all surfaces for dents, corrosion, cracks, dirt and other foreign matter which might result in improper or faulty operation of the recorder. Inspect all electrical leads for proper connections, cracked or frayed insulation, evidence of excessive heating, or poor contact.

Inspect all moving parts for signs of excessive wear, binding, or inability to maintain good service without affecting other components.

LUBRICATION

TABLE V-1

LUBRICATION CHART

PERIOD	LUBRICATION POINT	LUBRICANT
Monthly	1. The eccentric cam or the ribbon drive motor (inkless type)	1. SAE-30 machine oil
Once each year	1. All shaft bearings of chart carriage and drive units (Fig. 5-1 and 5-2)	1. SAE-30 machine oil
	2. Main drive motors - oil to gear box through the rear of the chart carriage (Fig. 5-3 and 5-4)	2 & 3. GE oil, Cat. No. 5445K42-001. CAUTION: Do not oil the high or low speed pawls of a three-plate main drive asm. (Fig. 5-4). These pawls should be kept clean to prevent any stickiness. A cleaning solvent leaving no residue, such as carbon tet., is suggested.
	3. Reroll drive motor - oil the two wicks as shown in Fig. 5-5.	
	Telechron* synchronous motors are permanently lubricated.	
Once each three years	1. Grease grooves of internal shaft in main drive unit (Fig. 5-4). This requires disassembly of the main drive unit.	1. Esso Beacon 325 grease (or equivalent) (Available from GE by ordering Cat.No. 5114K41)
	2. Hand-wound spring clock (Fig. 5-6). Refer to "Removal of Hand-wound Spring Clock". Oil all bearings and pivots of the power gear train.+	2. Clock oil**
	3. Pivots of the spring clock escapement, governor and constant torque mechanism.+	3. Clock oil**

(Continued)

TABLE V-1 (Cont.)

LUBRICATION CHART

PERIOD	LUBRICATION POINT	LUBRICANT
	4. Gear teeth of power gear train including all gears in the winding mechanism and rerolling mechanism including all gears between the large barrel gear and the governor.+ CAUTION: DO NOT lubricate the gear teeth in the escapement, constant torque mechanism, or differential.	4. Beacon 325 grease (or equivalent)
Only if main spring is disassembled	Main spring	Light graphite grease**

*Registered Trade-Mark of the General Electric Company.

**Clock oil and graphite grease may be obtained from a horological supply house or watch repair shop.

+Applies only to indoor usage under reasonable environmental conditions. Outdoor applications involving dusty locations or extremes in temperature changes require more frequent lubrication, preferably just prior to onset of winter.

CLEANING (PEN)

1. Lift the pen from the pen saddle.

NOTE: Immediately upon removal, tip the pen upside down to prevent the ink from flowing out.

2. Fill the pen starter with clean hot water.

3. Insert the back end of the pen tube into the tip of the pen starter and then try to force water through the pen. If a steady stream of water can not be forced through the pen, try to work the small, wire, pen cleaner supplied through the tip of the pen. Remove the wire and then try to force a stream of water through the pen.

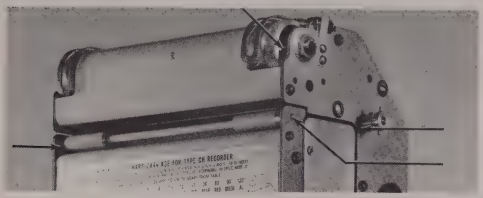
4. Repeat Steps 2 and 3 until a steady stream of water can be forced through the pen.

5. Empty the water from the pen starter and then force air through the pen, using the pen starter.

NOTE: On some models cleaning is facilitated by the addition of a removable nylon housing which contains the platinum irridium tip. This assembly (housing and tip) may be cleaned in the manner described above or replaced if the user desires.

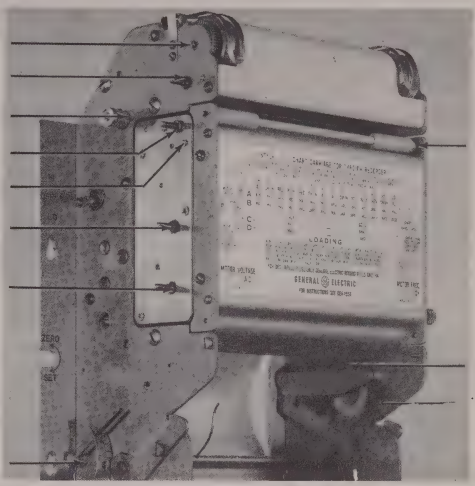
TROUBLE SHOOTING

The following troubleshooting information will be helpful in determining the probable cause and the remedy of operating difficulties. The chart does not cover every possibility, but functions as a guide in determining the remedial actions to be taken. If the difficulty can not be corrected, the unit can be returned for re-



APPLY ONE DROP OF OIL GE CAT. NO. 5445K42-001 AT POINTS INDICATED.

Fig. 5-1. Chart-carriage lubrication (also see Fig. 5-2)



APPLY ONE DROP OF OIL GE CAT. NO. 5445K42-001 AT POINTS INDICATED.

Fig. 5-2. Chart-carriage lubrication (also see Fig. 5-1)

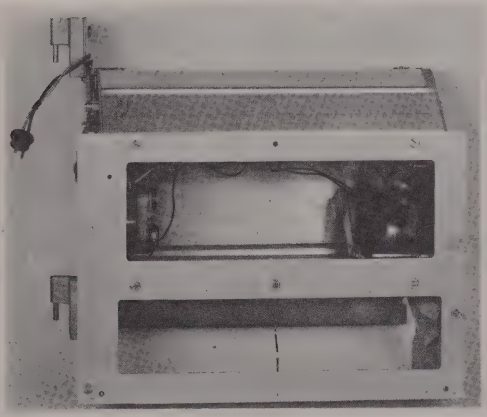
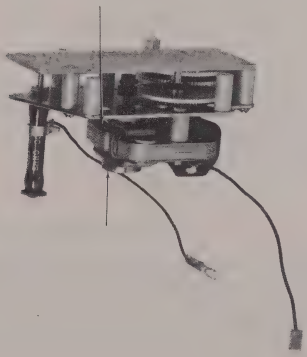


Fig. 5-3. Rear view of chart-carriage assembly (Style 2)

Fig. 5-4. Main-drive unit, double speed



APPLY SEVERAL DROPS OF OIL GE CAT. NO. 5445K42-001 AT POINTS INDICATED

Fig. 5-5. Reroll-drive unit

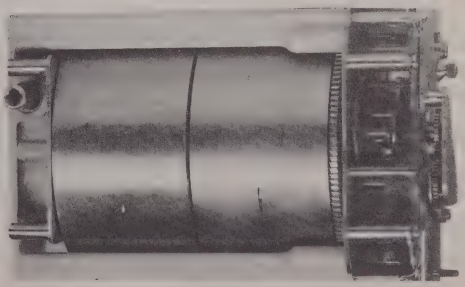


Fig. 5-6. Hand-wound spring clock with dust cover removed from gear train

pairs by obtaining shipping instruction from the nearest General Electric sales office. They will also provide the address of the nearest instrument service facility.

TROUBLE

APPARENT STICKINESS OF MEASURING MECHANISM

A. Excessive pen pressure

Remedy: Check for proper balance of the primed pen. The pen should rest on the paper with the minimum of pressure needed to write properly. To correct, rebalance the pen (filled with ink) with the balance weights provided on it.

NOTE: Skips in the recorded trace are the rule rather than the exception when the measured quantity is suddenly varied a large amount, such as from zero to 120 volts on a 150-volt voltmeter when the pen is properly balanced.

B. Rubbing of pen siphon tube

Remedy: Check the pen siphon tube for rubbing on the edge of the opening in the inkwell when moving the pen from zero to full scale. If it appears to touch the edge of the opening in the inkwell cover, check the inkwell. It should be properly seated in the slots on the ink shield. If the pen continues to rub, remove it from the pen saddle and straighten the siphon tube. It should be 90 degrees to both the pen tube and the pen trunnion. Recheck for rubbing. A slight adjustment is also available by loosening the four holding screws in the ink shield and sliding the shield forward or back.

C. Rubbing of the pen target

Remedy: With the pen properly installed, primed, and balanced, and resting on the chart paper, and with the scale in the normal operating position, check for interference between the pen target and the scale from zero to full scale. To correct, bend the target slightly away from the scale and recheck. On pens having a nylon tip and target assembly, obtain clearance by loosening the four scale bracket holding screws and rotating slightly upward. Care should be taken that the bracket does not interfere with the underside of the inkwell.

D. Friction in pen trunnions

Remedy: Check for friction in the pen trunnions by lifting the pen from the paper and releasing it. A properly balanced and primed pen should return to the paper slowly and smoothly, without binding between the pen and the pen saddle. To correct, spread the pen saddle slightly and recheck.

E. Pen saddle loose

Remedy: Check for looseness of the pen saddle with respect to the armature shaft. Tighten the small chuck nut on top of the armature shaft directly below the black plastic ink tray. Use a non-magnetic wrench on DC mechanism to avoid damage to the armature.

F. Rubbing of damping vane

Remedy: Check for rubbing of the damping vane in the damping-magnet gap.

Adjust the vane to insure clearance in all positions from zero to full scale. Check for foreign particles in the damping-magnet gap. Remove the damping-magnet assembly and clean. Replace damping-magnet assembly and adjust this assembly to its former position or until it is properly damped. The instrument is properly damped when the full-scale input signal can be applied instantaneously to drive the pointer from the left-hand end of the scale to the right-hand end of the scale and the pointer will not overshoot the right-hand end of the scale by more than one percent of scale length (0.04 inches). The damping can be changed by loosening the screw at the bottom of the damping magnet and moving the damping magnet toward the front of the mechanism to decrease the damping, or toward the rear of the mechanism to increase the damping. Tighten the screw after correcting the damping.

G. "Dirt" in magnet gap (d-c instruments only)

Remedy: Check for foreign material (magnetic or non-magnetic "dirt") in the magnet gap rubbing on the armature coil. Remove the material with non-magnetic tools, being careful not to damage the armature coil. Recheck for rubbing.

FOR MAINTENANCE OF CHART CARRIAGES SEE PUBLICATION 4557K10-010

REMOVAL OF HAND-WOUND SPRING CLOCK

Remove the clock from the chart carriage as a unit. The clock has two separate outputs, each of which is removable as a complete subassembly. Remove the jeweled escapement as a unit from its associated gear train.

CAUTION: Allow the clock to unwind completely before starting disassembly. (Remove the rate gears and run at high speed.)

ADJUSTMENT OF STYLUS (Inkless-type Recorder)

If it becomes necessary to readjust the stylus in an inkless-type recorder, proceed as follows:

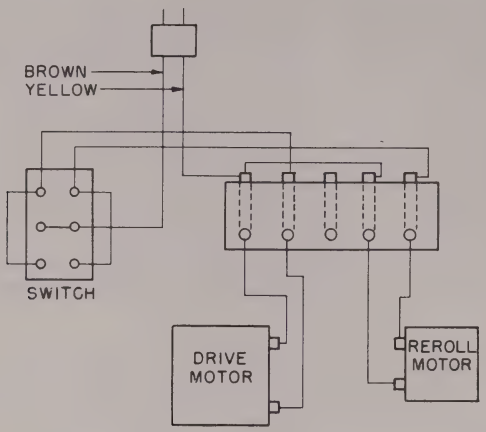
1. Check the total drop at the stylus tip with the motor off. The drop should be from 1/4 to 1/2 inch from the maximum upward position of the stylus tip to the surface of the writing table. If any correction is necessary to obtain this drop, it may be made by bending the stylus slightly. Do not over-bend the stylus.

2. Check the zero setting with the stylus operating and readjust if needed.

CAUTION: Do not exchange a stylus with one from another recorder. Each stylus is individually adjusted to the recorder with which it was calibrated.

REPAIR AND CALIBRATION

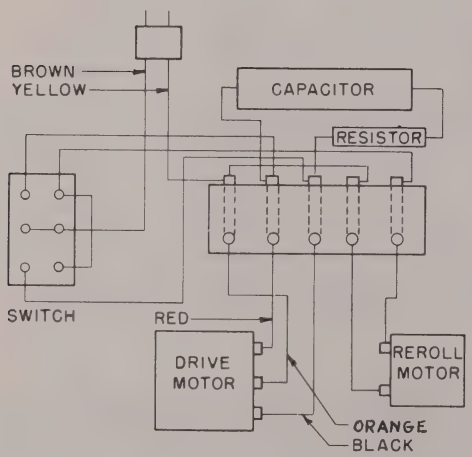
If the recorder needs repair or a check of its calibration is desired, obtain shipping instructions from the nearest General Electric sales office. Pack the recorder carefully in a nest of shredded newspaper or excelsior, and send it to the instrument service facility specified by the sales office.



SINGLE SPEED ELECTRIC-LOW SPEED

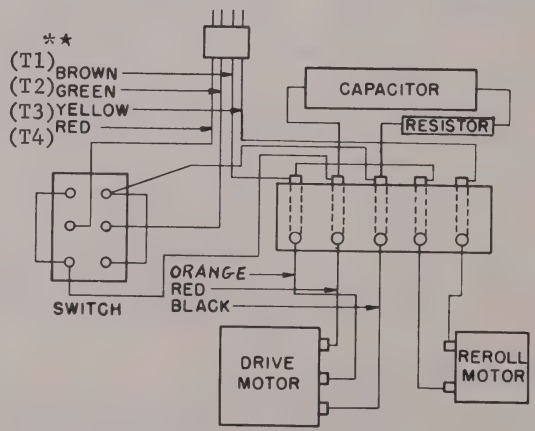
Fig. 5-7. Wiring diagram for Style 2 chart carriage, 120 and 240 volts*

*Current manufacture are all 120V self-contained ratings. If 240V rating is required, a step-down transformer is mounted within the case. External connections will remain the same.



DOUBLE SPEED ELECTRIC

Fig. 5-8. Wiring diagram for Styles 6 chart carriage, 120-volts



DOUBLE SPEED ELECTRIC-EXTERNAL SWITCHING

Fig. 5-9. Wiring diagram for Style 7 chart carriage, 120-volts

**T1,2,3,4 refer to terminals shown in external connection Fig 3-10

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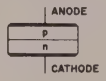
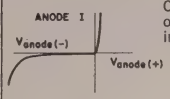
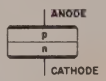
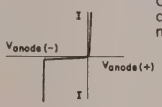
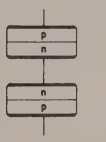
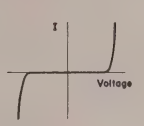
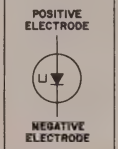
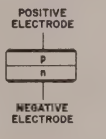
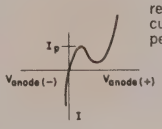
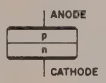
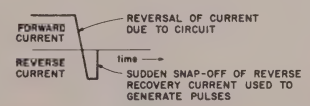
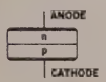
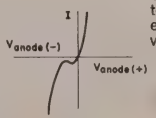
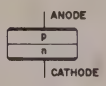
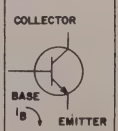
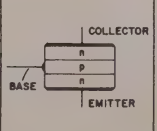
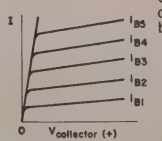
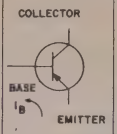
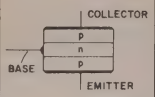
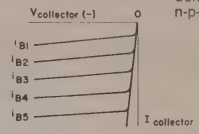
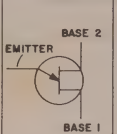
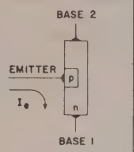
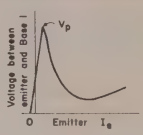
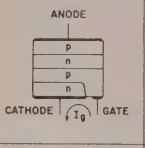
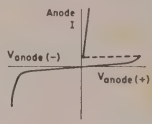
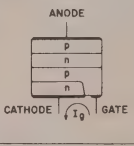
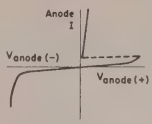
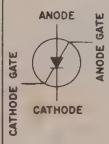
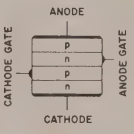
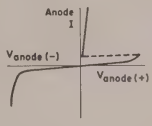
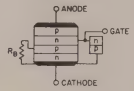
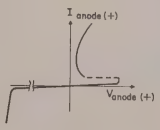
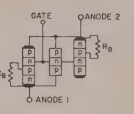
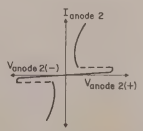
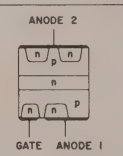
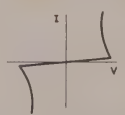
GENERAL ELECTRIC

SEMICONDUCTOR PRODUCTS DEPARTMENT
SYRACUSE, NEW YORK

MAJOR GENERAL ELECTRIC SEMICONDUCTOR COMPONENTS

Name of Device	Circuit Symbol	Commonly Used Junction Schematic	Electrical Characteristics	Max Ratings Available From G. E.	Major Applications	Roughly Analogous To:
Diode or Rectifier			 Conducts easily in one direction, blocks in the other	500 Amps 1800 Volts	Rectification Blocking Detecting Steering	Check valve Diode tube Gas diode
Avalanche (Zener) Diode			 Constant voltage characteristic in negative quadrant	22 Volts 1 Watt	Regulation Reference Clipping	V-R tube
Thyrector			 Rapidly increasing current above rated voltage in either direction	70 A peak pulse (2" Sq. cell)	Transient voltage suppression and arc suppression	Thyrite Two avalanche diodes in inverse-series connection
Tunnel Diode			 Displays negative resistance when current exceeds peak point current I_p	Peak point current = 100 ma Resistive cutoff freq. = 40 Gc	UHF converter Logic circuits Microwave circuits	None
Snap Diode or Step Recovery Diode				Storage time 5 to 500 nsec Snap time = 2 nsec.	Pulse and harmonic generation 3×10^{-9} sec.	None
Back Diode			 Similar characteristics to conventional diode except very low forward voltage drop	5 ma 400 mV	Microwave mixers and low power oscillators	None
Light Emitting Diode			Similar characteristics to conventional diode except junction emits radiation when pulse of forward current is passed	125 mW 5.5×10^{14} photons/sec.	Electrically isolated communications Sound on film recording Remote control	Light bulb
n-p-n Transistor			 Constant collector current for given base drive	200 Volts 60 Watts	Amplification Switching Oscillation	Pentode Tube

MAJOR GENERAL ELECTRIC SEMICONDUCTOR COMPONENTS

Name of Device	Circuit Symbol	Commonly Used Junction Schematic	Electrical Characteristics		Max Ratings Available From G. E.	Major Applications	Roughly Analogous To:
p-n-p Transistor				Complement to n-p-n transistor	40 Volts 0.500 Watts	Amplification Switching Oscillation	None
Unijunction Transistor (UJT)				Unijunction emitter blocks until its voltage reaches V_p, then conducts	35 Volts 0.450 Watts	Interval timing Oscillation Level Detector SCR Trigger	None
Silicon Controlled Rectifier (SCR)				With anode voltage (+), SCR can be triggered by I_g, remaining in conduction until anode I is reduced to zero	500 Amps 1800 Volts	Power switching Phase control Inverters Choppers	Gas thyratron or ignitron
Light Activated SCR* (LASCR)				Operates similar to SCR, except can also be triggered into conduction by light falling on junctions	1.6 Amps 200 Volts	Relay Replacement Position controls Photoelectric applications Slave flashes	None
Silicon Controlled Switch* (SCS)				Operates similar to SCR except can also be triggered on by a negative signal on anode-gate. Also several other specialized modes of operation	100 Volts 200 mA	Logic applications Counters Nixie drivers Lamp drivers	Complementary transistor pair
Silicon Unilateral Switch (SUS)				Similar to SCS but zener added to anode gate to trigger device into conduction at ~ 8 volts. Can also be triggered by negative pulse at gate lead.	0.350 Watts 0.200 Amps 10 Volts	Switching Circuits Counters SCR Trigger Oscillator	Shockley or 4-layer diode
Silicon Bilateral Switch (SBS)				Symmetrical bilateral version of the SUS. Breaks down in both directions as SUS does in forward.	0.350 Watts 0.200 Amps 10 Volts	Switching Circuits Counters TRIAC Phase Control	None
Triac				Operates similar to SCR except can be triggered into conduction in either direction by (+) or (—) gate signal	10 Amps 400 Volts	AC switching Phase control Relay replacement	Two SCR's in inverse parallel
Diac Trigger				When voltage reaches trigger level (about 35 volts), abruptly switches down about 10 volts.	40 Volts 2 Amps peak	Triac and SCR trigger Oscillator	Neon lamp

*Light Activated SCS also possible.

SECTION VI

RECOMMENDED SUPPLY PARTS & ACCESSORIES

RECOMMENDED SUPPLY PARTS

In addition to the supply parts which are furnished with recorder, it is recommended that ink and record rolls be available at all times. Replace these as soon as it is evidenced that stock is low.

Record Rolls

The record roll catalog number is stamped on the rating plate. This number has two parts; four digits separated from a fifth digit by a dash. The first four digits designate the record roll distribution which matches the marking on the recorder scale plate. The last digit identifies the time stamping.

Record rolls with timing lines are available in the following speeds: 1/4, 1/2, 3/4, 1, 1-1/2, 2, 3 and 4 inches per hour. Record rolls without timing lines, designated as "-0", are available for all other speeds.

When ordering record rolls, please quote the catalog number from the rating plate plus the time marking desired if different from that specified.

Ink

Please order ink by catalog number (4496K----) as identified in Table IV-2.

RENEWAL PARTS

Renewal parts information applicable to the Type CH recorders, is contained in publication 4557K10-350.

Lubricating Oil

Use lubricating oil Cat. No. 5445K42P001 (furnished with the recorder).

ACCESSORIES

MARKER PEN ASSEMBLIES

NOTE: Marker-pen assemblies may be used on all Type CH recorders.

Marker-pen assemblies are mounted on the ink shield on one or both sides to make marks on the margins of the chart. (See Fig.6-1 and 6-2.) The marker-pen assemblies are available for either 120-volt AC or 6-volt DC operation. They may be adapted for use at higher voltages by inserting resistors of the proper rating in series with the coil. The leads of the marker-pen assemblies are connected to the upper terminal block; the left-hand pen to terminals 11 and 12, and the right-hand pen to terminals 9 and 10. The marker-pen assemblies are supplied with their own factory-sealed inkwells.

All components, except the pen arms, are interchangeable for left-hand and right-hand installations.

IMPORTANT: Before operating the marking pens, complete the PRELIMINARY OPERATION section below.

INSTALLATION

If the marker pens are to be installed on a recorder in the field, follow the instructions (Dwg. No. K-5465853) furnished with the conversion kit. A copy of this drawing is provided as Fig. 6-2 within this section.

PRELIMINARY OPERATION

1. Remove shipping cap from the ink container and replace it with cap having an opening for the stem of the marker pen.

2. Press the ink container into clamp until it "bottoms" on the ink shield.

3. Insert stem of marker pen in the inkwell and engage the tail of pen in the "V"-shaped slot.

4. Start the pen inking. (Refer to the procedure provided in Section IV, Preliminary Operation, Inking Pen.)

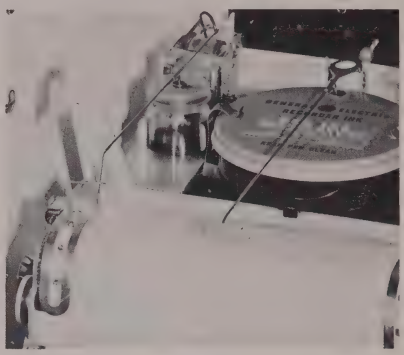


Fig. 6-1. Left-hand marker-pen assembly in recorder (recorder scale removed)

HEATERS

The minimum temperature at which some recorders will operate properly may be extended below -5F by adding heaters and a thermostat (Fig. 7-3). The thermostat closes at approximately 35F and opens at approximately 65F. For further information on heaters, contact the nearest General Electric sales office, specify complete model number of the recorder.

CHART-CARRIAGE-DRIVE SHAFT EXTENSION

NOTE: The following instructions apply to all Type CH single recorders.

The chart carriage of an additional recorder, without its own drive assembly, may be driven by the insertion of a Twin Instrument Drive Coupling and gearshift extension between the two chart carriages. This accessory also may be used between two carriages, or more, which are controlled from a common switching arrangement. The addition of such allows the units to be shut off or started simultaneously without incurring any timing differentials due to forward backlash or coast down characteristics of individual chart carriages. Without this feature, a bank of commonly connected recorders could reflect small differences in timing if not reset after each "on" cycle.

To interconnect the chart carriages, proceed as follows:

1. Remove the chart carriages from their respective recorders, and install the Gear-Shaft Assemblies (assembly instructions are furnished upon order).

2. Remove snap buttons from the adjoining Recorder Cases (forward sides of case).

3. Replace the chart carriages in the recorder, and slide a drive coupling over the gear shaft knob (previously installed per Step 1).

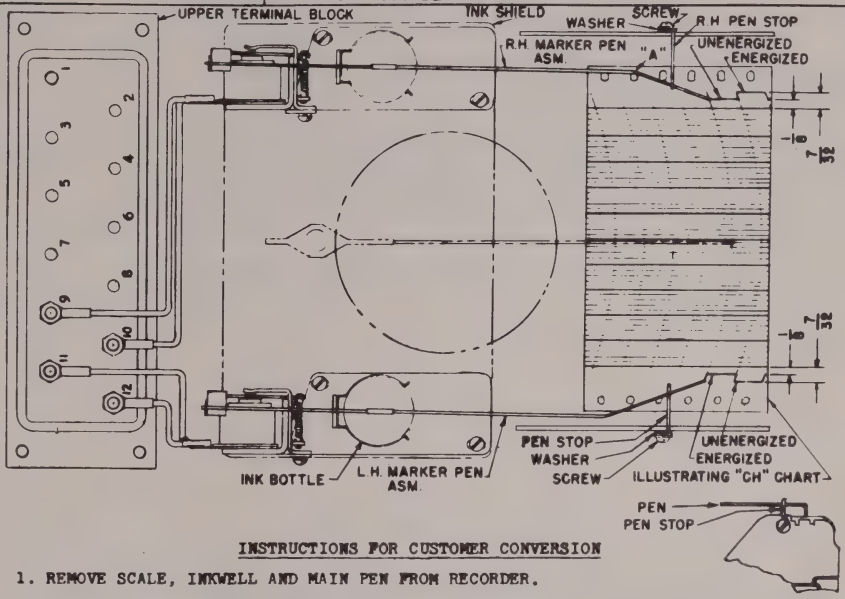
4. Insert the shaft extension (1/4" dia. rod of desired length) into the couplings, and tighten the set screws in each coupling.

5. Rotate the chart drives by thumbing the timing drum until each recorder agrees in its time-setting.

GENERAL ELECTRIC K-5465853 SHEET 2 OF 2 SHEETS

TITLE INSTRUCTIONS FOR INSTALLATION, CONNECTION AND ADJUSTMENT OF MARKER PEN

F.M.F. CH RECORDER



REVISIONS

A — R. S. Jubbal — Nov. 21, 1956 — [1] RETRACED WITH GEN. CHGS. IN NOTES 7, 8 & 11; TRANS. NOTES 12 THRU 15 TO SHEET 2.

INSTRUCTIONS FOR CUSTOMER CONVERSION

1. REMOVE SCALE, INKWELL AND MAIN PEN FROM RECORDER.
2. OPEN UP CLEARANCE HOLE FOR #10 SCREW (APPROX. .204 DIA.) IN PROPER LOCATIONS ON UPPER TERMINAL BLOCK. NOTE: TERMINAL #9 & #10 FOR RH MARKER PEN #11 & #12 FOR LH MARKER PEN.
3. REMOVE TERMINAL STUDS AND HARDWARE FROM ENVELOPE AND ASSEMBLE.
4. INSTALL MARKER PEN ASSEMBLY ON BOSSES PROVIDED ON INK SHIELD.
5. REMOVE MOUNTING SCREW ON CHART CARRIAGE PLATE AND ASSEMBLE PEN STOP.
6. CONNECT LEADS TO PROPER TERMINALS.
7. REMOVE SHIPPING CAP FROM INKWELL AND REPLACE WITH CAP HAVING OPENING FOR STEM OF MARKER PEN. PRESS INKWELL INTO CLAMP ALL THE WAY DOWN UNTIL IT "BOTTOMS" ON THE INK SHIELD.
8. INSERT MARKER PEN. CHECK FOR FREEDOM OF THE PEN BY PRESSING DOWN LIGHTLY ON THE PEN IMMEDIATELY ABOVE THE INKWELL. THE PEN SHOULD BE FREE TO PRESS DOWN AND SPRING BACK FROM 1/16 TO 1/8. IF NOT, REMOVE PEN AND CHECK THE RIGHT ANGLE BEND IN THE PEN TUBE. ALSO, TAIL OF PEN SHOULD BE AT RIGHT ANGLES WITH THE PEN TUBE.
9. IF REQUIRED, BEND PEN AT POINT "A" TO UNENERGIZED POSITION SHOWN ON DRAWING.
10. REPLACE MAIN PEN AND INKWELL.
11. ALIGN MAIN PEN ON TIME LINE ARC (IF THE PAPER HAS TIME MARKINGS ON IT) BY ROTATING THE TIMING DRUM FORWARD, USING THE KNURLED PORTION. ADJUST MARKER PEN TIP IF REQUIRED, TO FALL ON THE SAME TIMING LINE BY MEANS OF THE SLOTTED HOLES IN THE MARKER PEN MOUNTING PLATE.

3A

PRINTS TO

MADE BY José María Tomás, FEB 14, 1956 — APPROVALS — INSTRUMENT — DIV OR DEPT — K-5465853 SHEET 2 OF 2 SHEETS

RELEASED M. Llamas / QEP Nov. 21, 1956 — WEST LYNN — LOCATION

FF 501 W 2 P ... PRINTED IN U.S.A.

Fig. 6-2. Instructions for Installation, Connection and Adjustment of Marker Pen (Sheet 1 of 2)

GENERAL ELECTRIC K-5465853

REV NO. | TITLE: INSTRUCTIONS FOR INSTALLATION, CONNECTION AND ADJUSTMENT OF MARKER PEN | CONT ON SHEET Final SH NO. 2

CONT ON SHEET SH NO. | FIRST MADE FOR CH RECORDER

REVISIONS

A Revised per EC 22-7225 ISSUED

12. DRAW INK THROUGH MARKER PEN AND START CHART CARRIAGE. ENERGIZE ELECTROMAGNET WITH PROPER VOLTAGE.

13. CHECK PEN THROW. MUST APPROXIMATE PATTERN SHOWN. ADJUST PEN STOP IF NECESSARY. CHECK FOR BOUNCE OF PEN TIP BOTH WHEN ENERGIZING AND DE-ENERGIZING THE ELECTROMAGNET. TO ELIMINATE BOUNCE, BEND TAIL OF PEN TO PROVIDE TENSION BETWEEN THE PEN AND THE PEN STOP IN BOTH THE ENERGIZED AND DE-ENERGIZED POSITION.

14. MARKER PEN SHOULD NOT INTERFERE WITH PAPER GUIDES (NOT SUPPLIED ON LATER MODELS) OR MAIN PEN.

15. REPLACE SCALE.

3A

PRINTS TO

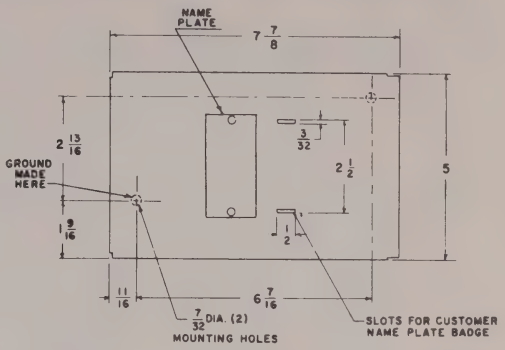
MADE BY [illegible] | APPROVALS | DIV OR DEPT. | K-5465853

ISSUED [illegible] | LOCATION WEST SYRACUSE | CONT ON SHEET SH NO.

FF-803-W2-P (80M) (4-56)
PRINTED IN U.S.A.

Fig. 6-2. Instructions for Installation, Connection and Adjustment of Marker Pen (Sheet 2 of 2)

Fig. 6-3. Heater thermostat (actual size)



PHASE-SHIFTING TRANSFORMERS

NOTE: For Product Support Data refer to General Electric Co., Somersworth, New Hampshire.

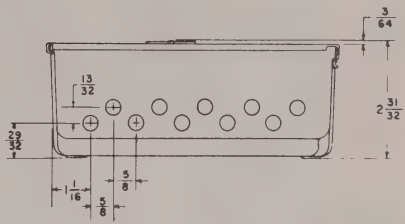


Fig. 6-4. Phase-shifting transformers used with varmeters

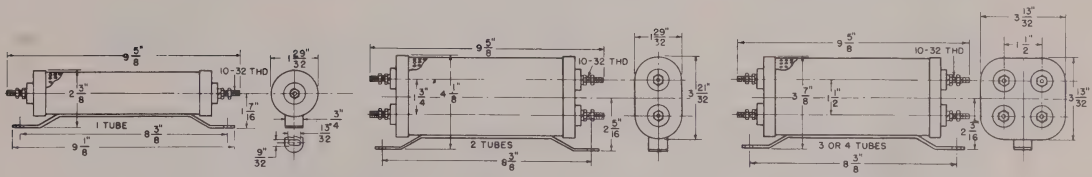


Fig. 6-5. External resistors for switchboard-type recorders.

VOLTAGE STABILIZER

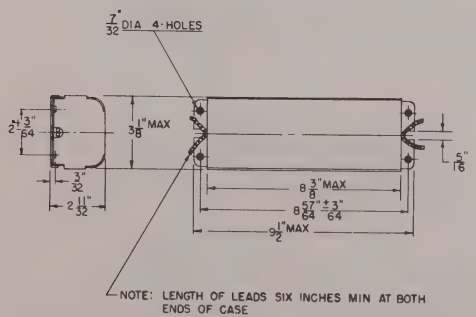


Fig. 6-6. Voltage stabilizer (95-130V input, output 115V)

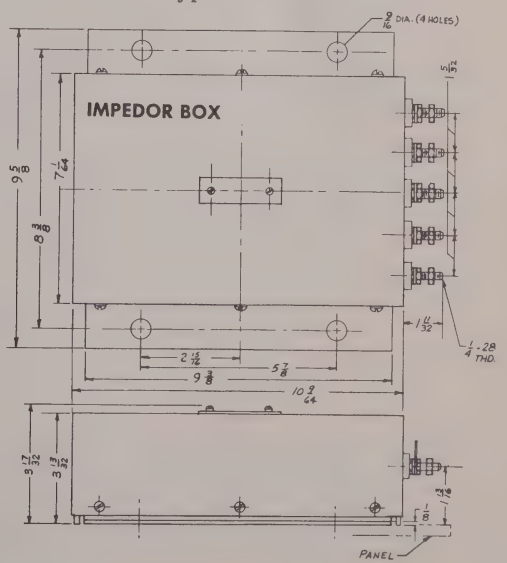
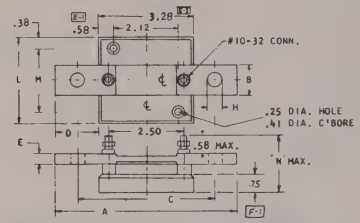


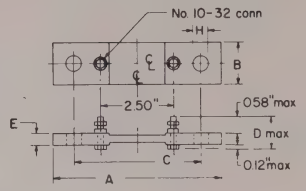
Fig. 6-7. Impedor box used with 1 MA center-tap DC recorder.



NOTE: ALL DIMENSIONS ARE NOMINAL EXCEPT "MAX." DIMENSIONS.

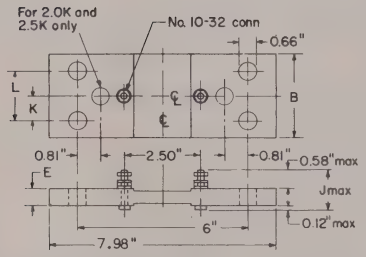
RTG. AMP	A	B	C	D	E	H	L	M	N
10, 15		.48	4.5	1.41		.28	2.88	2.12	
20		.58	4.5	1.41	.12	.28	2.88	2.12	1.83
30		.88	4.5	1.41		.41	3.88	3.12	
40		1.15	4.5	1.41		.41	3.88	3.12	
50		.71	4.5	1.41		.41	2.88	2.12	
60		.85	4.5	1.41		.41	3.88	3.12	
75		1.06	4.5	1.41	.14	.41	3.88	3.12	1.85
80	5.98	1.13	4.5	1.41		.41	3.88	3.12	
100		1.41	4.5	1.41		.41	3.88	3.12	
150		1.06	4.5	1.41	.19	.53	3.88	3.12	1.90
200		1.41	4.5	1.41		.53	3.88	3.12	
250		1.18	4.5	1.41	.29	.53	3.88	3.12	2.00
300		1.41	4.5	1.41		.53	3.88	3.12	
400		1.41	4.5	1.41		.53	3.88	3.12	
500		1.77	4.5	1.41	.34	.53	3.88	3.12	2.05
600		2.12	6	2.41		.66	5	4.24	
800	7.98	2.26	6	2.41	.44	.66	5	4.24	2.15
1K		2.83	6	2.41		.66	5	4.24	

Fig. 6-8. **Std. Sw'b'd & Portable Shunts (with base) 50 MV – Up to 1.0KA*** *(See Note 1 below)*
(Dwg. A-3148K10)



Rating in Amperes	A	B	C	D	E	H
75		1.06	4.5			0 41
80		1.13	4 5	0.85	0.14	0 41
100		1.41	4.5			0 41
150		1.06	4.5	0.90	0 19	0 53
200	5.98	1.41	4.5			0 53
250		1.18	4.5	1 00	0 29	0 53
300		1.41	4 5			0 53
400		1.41	4 5	1 05	0 34	0 53
500		1.77	4.5			0 53
600		2.12	6			0 66
800	7.98	2.26	6	1.15	0.44	0 66
1K		2 83	6			0 66
12K		2 83	6	1 20	0 49	0 66

Fig. 6-9. **Std. Sw'b'd. Shunts (without base) 50 MV–Up to 1.2 KA** †*(See Note 2 below)*
(Dwg. A-3148K11)



Rating in Amperes	B	E	L	K	J
1.5 K	3.02	0.59	1.75	0.88	1.30
2.0 K	4.04	0.59	2.50	1.25	1.30
2.5 K	3.92	0.74	2.50	1.25	1.45

Fig. 6-10. **Std. Sw'b'd. Shunts (without base) 50 MV–Up ro 2.5KA** ††*(See Note 3 below)*
(Dwg. A-3148K12)

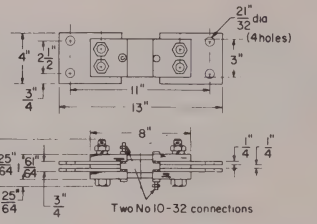


Fig. 6-11. **Std. Sw'b'd. Shunt 50 MV–3.0KA**
(Dwg. A-3148K17)

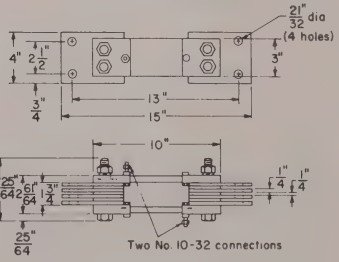


Fig. 6-12. **Std. Sw'b'd. Shunt 100 MV–3.0KA**
(Dwg. A-3148K19)

Note:

1. * For 100 millivolt shunt dimensions, add 2.0 inches to "A" and "C" dimensions, and horizontal base dimensions indicated above, and also to the 2.50 inch dimension between terminals.
2. † For 100 millivolt shunt dimensions, add 2.0 inches to "A" and "C" dimensions indicated above, and also to the 2.50 inch dimension between terminals.
3. †† For 100 millivolt shur : dimensions, add 2.0 inches to the 7.98 inch, 6.0 inch, and 2.50 inch dimensions shown above.

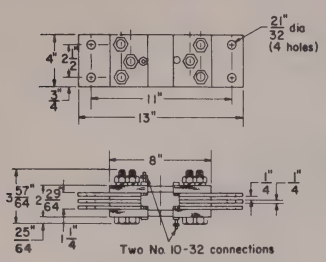


Fig. 6-13. **Std. Sw'b'd. Shunt**
50 MV–5.0KA Shunt
(Dwg. A-3148K21)

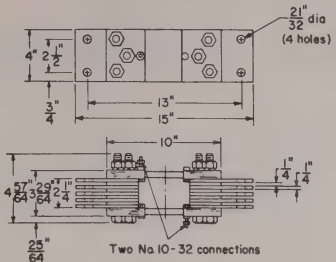


Fig. 6-14. **Std. Sw'b'd. Shunt**
100 MV–4.0KA
(Dwg. A-3148K25)

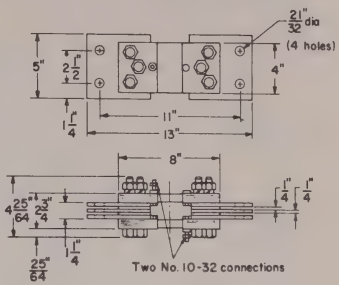


Fig. 6-15. **Std. Sw'b'd. Shunt**
50 MV–5.0KA
(Dwg. A-3148K22)

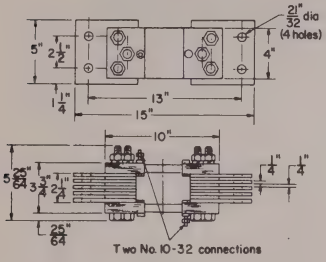


Fig. 6-16. **Std. Sw'b'd. Shunt**
100 MV–5.0KA
(Dwg. A-3148K26)

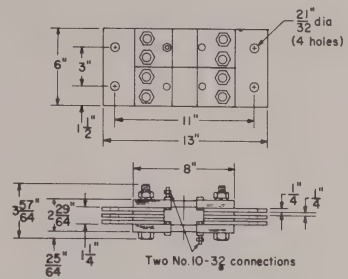


Fig. 6-17. **Std. Sw'b'd. Shunt**
50 MV–6.0KA
(Dwg. A-3148K18)

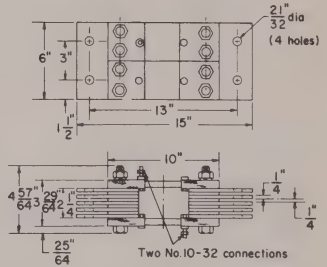


Fig. 6-18. **Std. Sw'b'd. Shunt**
100 MV–6.0KA
(Dwg. A-3148K20)

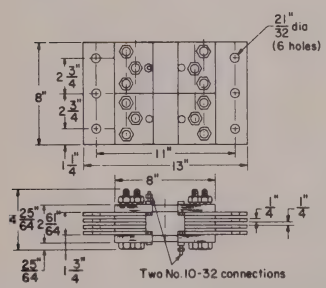


Fig. 6-19. **Std. Sw'b'd. Shunt**
50 MV–8.0KA
(Dwg. A-3148K23)

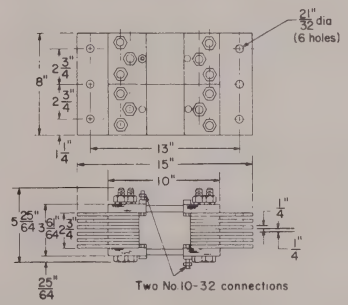


Fig. 6-20. **Std. Sw'b'd. Shunt**
100 MV–8.0KA
(Dwg. A-3148K27)

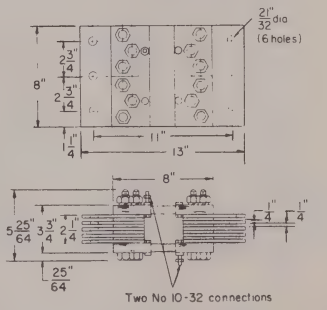


Fig. 6-21. **Std. Sw'b'd. Shunt**
50 MV–10.0KA
(Dwg. A-3148K24)

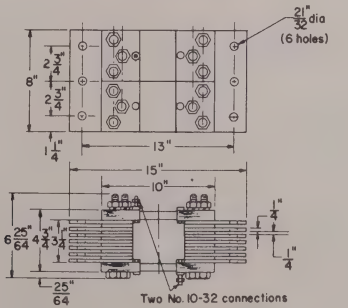


Fig. 6-22. **Std. Sw'b'd. Shunt**
100 MV–10.0KA
(Dwg. A-3148K28)

SECTION VII

EXTERNAL CONNECTION DIAGRAMS

(FOR LOWER TERMINAL BLOCK ONLY)
(FOR UPPER TERMINAL BLOCK SEE EXTERNAL CONNECTIONS PAGE 11)

NOTE: CH-37 duplex-external connection diagram is furnished with the recorder according to the particular application.

CH-39 twin-external connection for each side is same as though it were a single recorder in this section.

CH-6 for external connections, see diagram on back of the recorder.

CH-7 and CH-9 see separate instruction book for external connections.

Diagrams below are for lower terminal block only. For upper terminal block see Fig. 3-9 and 3-10.

Diagram	Fig.	Page
VOLTMETERS, AC AND DC	7-1	36
AMMETERS, AC AND DC	7-2	37
WATTMETERS, SINGLE PHASE	7-3	37
WATTMETERS, 3-WIRE, 3-PHASE, OR 3-WIRE SINGLE PHASE	7-4	37
WATTMETERS, 2-1/2 ELEMENT, 4-WIRE, 3-PHASE	7-5	38
UNIVERSAL WATTMETER, 2-WIRE, SINGLE-PHASE	7-6	38
UNIVERSAL WATTMETER, 120-VOLT ELEMENT, 3-WIRE, 3-PHASE	7-7	39
UNIVERSAL WATTMETER, 240-VOLT ELEMENT, 3-WIRE, 3-PHASE	7-8	39
UNIVERSAL WATTMETER, 480-VOLT ELEMENT, 3-WIRE, 3-PHASE	7-9	39
UNIVERSAL WATTMETER, 120-VOLT ELEMENT, 4-WIRE, 3-PHASE	7-10	40
UNIVERSAL WATTMETER, 240-VOLT ELEMENT, 4-WIRE, 3-PHASE	7-11	40
UNIVERSAL WATTMETER, 480-VOLT ELEMENT, 4-WIRE, 3-PHASE	7-12	40
VARMETER, 3-WIRE, 3-PHASE	7-13	41
VARMETER, 4-WIRE, 3-PHASE	7-14	41
VARMETER, 4-WIRE, 3-PHASE, 3 PT'S CONNECTED Y-Y	7-15	42
FREQUENCY METER (WITH EXTERNAL IMPEDOR)	7-16	42
FREQUENCY METER (WITH SELF-CONTAINED IMPEDOR)	7-17	42
TACHOMETER, RECTIFIED AC OR DC	7-18	42
POWER FACTOR METER (WITH EXTERNAL TRANSDUCER	7-19	42

IMPORTANT

For convenient reference, the applicable external connection diagram can be cut out and pasted on the rear of the recorder.

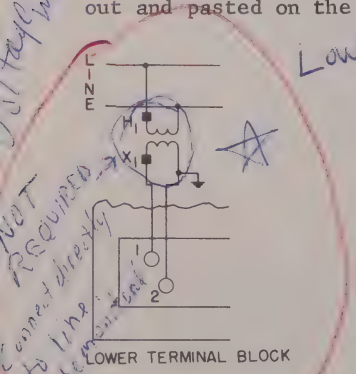


TABLE OF CONNECTIONS	
RATING	TERMINALS
SINGLE OR LOWEST	1 & 2
2 ND	1 & 4
3 RD	1 & 6
4 TH	1 & 8
5TH	1 & 10

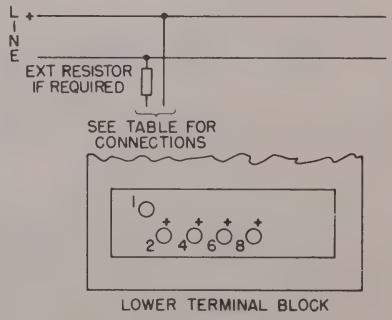


Fig. 7-1. External connections of a-c and d-c voltmeters (polarity signs apply to d-c voltmeters).

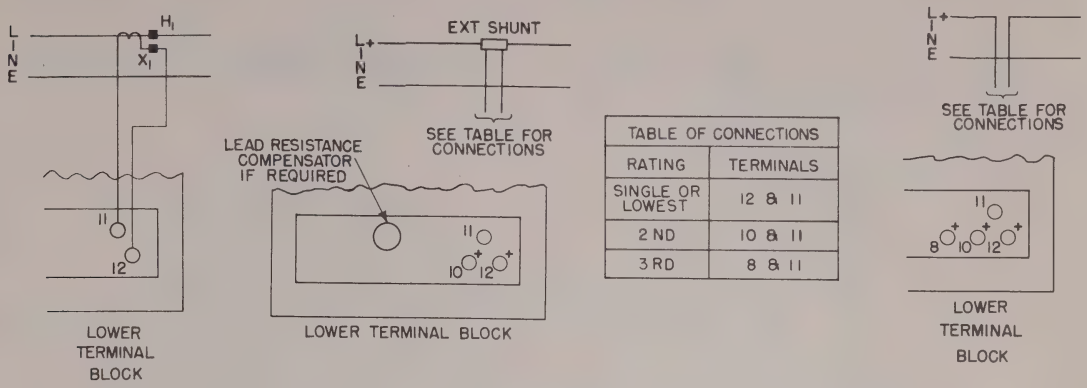


TABLE OF CONNECTIONS	
RATING	TERMINALS
SINGLE OR LOWEST	12 & 11
2 ND	10 & 11
3 RD	8 & 11

Fig. 7-2. External connections of a-c and d-c ammeters (polarity applies to d-c ammeters).

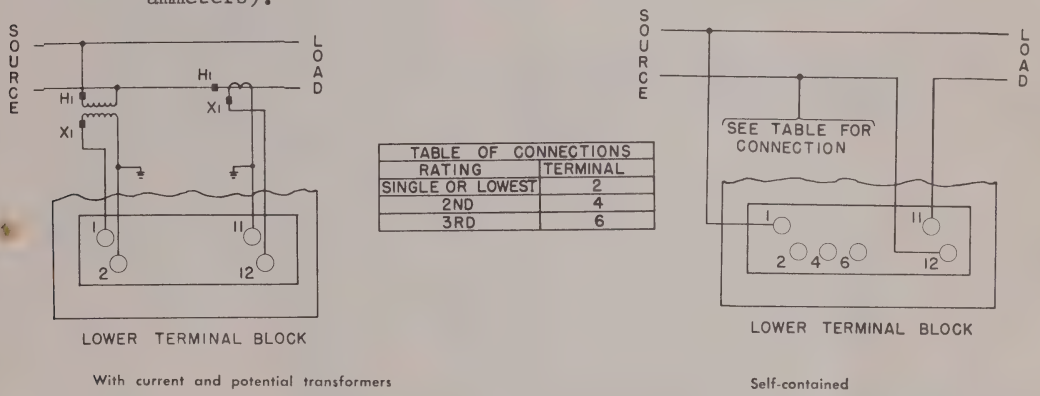


TABLE OF CONNECTIONS	
RATING	TERMINAL
SINGLE OR LOWEST	2
2ND	4
3RD	6

Fig. 7-3. External connections of single-phase wattmeter*

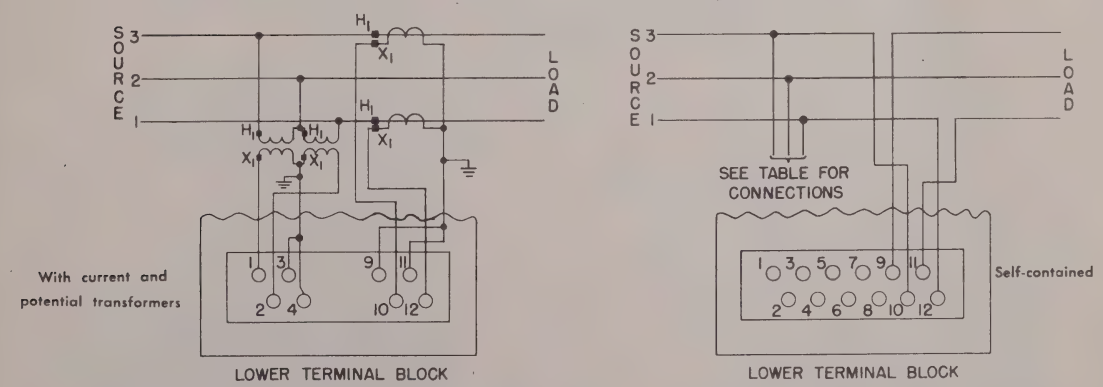
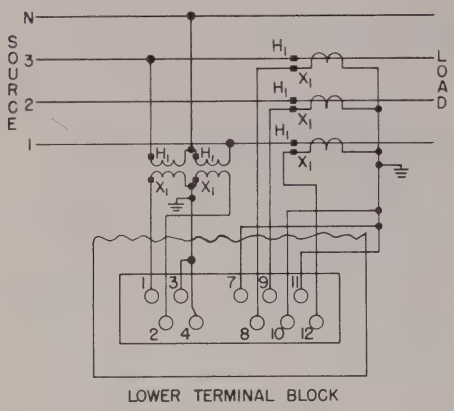


TABLE OF POTENTIAL CONNECTIONS				
RATING	LINE →	1	2	3
SINGLE OR LOWEST	TERMINAL	2	3 & 4	1
2ND	TERMINAL	2	5 & 6	1
3RD	TERMINAL	2	7 & 8	1

Fig. 7-4. External connections of 2-element wattmeter, 3-wire, 3-phase, or 3-wire, single-phase. *

*The connection diagram applying to your recorder may be cut out and pasted on the back of the recorder case.



Potential coils are connected internally between 1 & 3 and 2 & 4. Current coils are connected internally between 7 & 8, 9 & 10, and 11 & 12.

With current and potential transformers

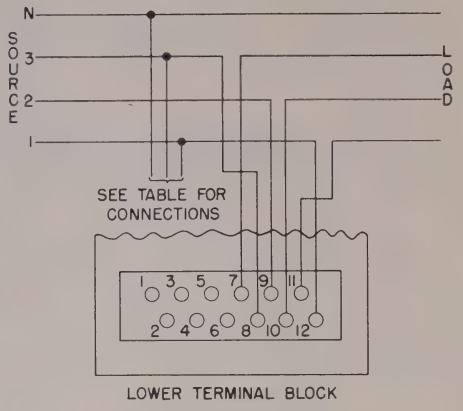
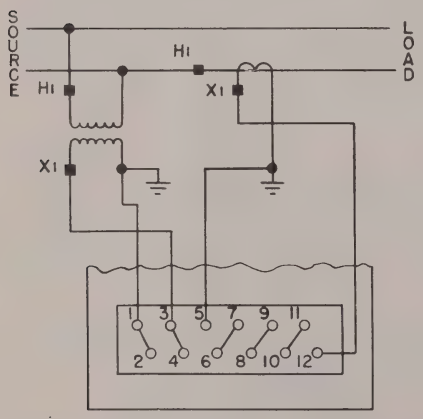


TABLE OF POTENTIAL CONNECTIONS					
RATING	LINE →	N	3	2	1
SINGLE OR LOWEST	TERMINAL	3&4	1	–	2
2ND	TERMINAL	5&6	1	–	2

Self-contained

Fig. 7-5. External connections of 2 1/2 element wattmeter, 4-wire, 3-phase*



POTENTIAL COILS ARE CONNECTED INTERNALLY BETWEEN TERMINALS 1&3 AND 2&4
CURRENT COILS ARE CONNECTED INTERNALLY BETWEEN TERMINALS 5&6, 7&8, 9&10, 11&12

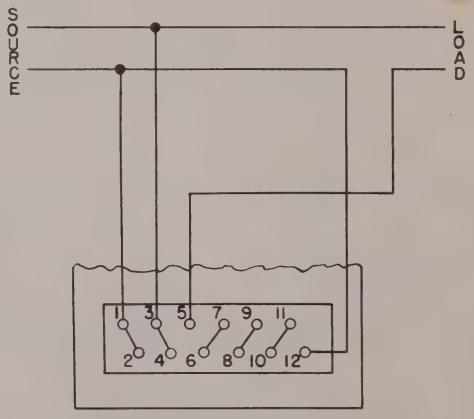


TABLE OF CURRENT CONNECTIONS	
RATING	CONNECT TERMINALS
LOWEST	6 To 7, 8 To 9, & 10 To 11
2ND	5 To 7, 6 To 8, 8 To 9, 9 To 11, & 10 To 12

Fig. 7-6. External connections of universal wattmeter for 2-wire single-phase*

*The connection diagram applying to your recorder may be cut out and pasted on the back of the recorder case.

FOR 120 VOLT CHART DRIVE	UPPER TERM. BLOCK, TERM. 1-2
FOR 240 VOLT CHART DRIVE	UPPER TERM BLOCK, TERM. 1-4
HEATER	UPPER TERM. BLOCK, TERM. 7-8
R.H. MARKER PEN	UPPER TERM. BLOCK, TERM. 9-10

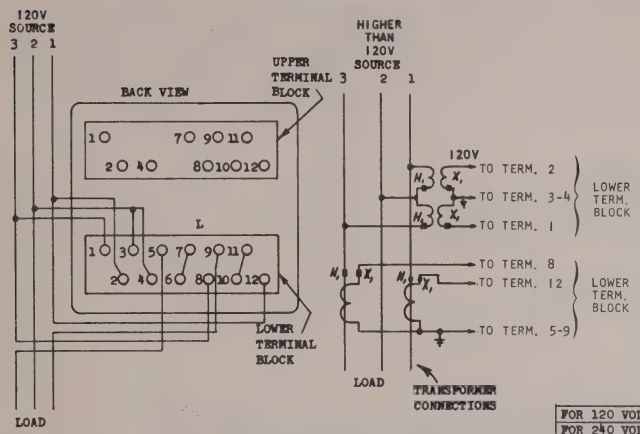
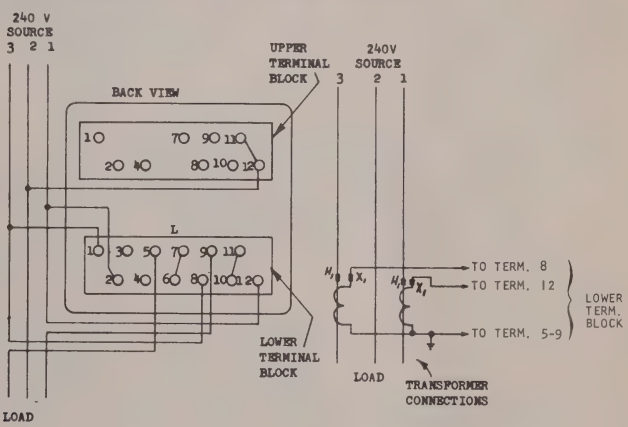


Fig. 7-7. External connections, 120-volt potential rating for element, Universal Wattmeter, 3-wire, 3-phase, without and with potential and current transformers.*

FOR 120 VOLTCHART DRIVE	UPPER TERM. BLOCK, TERM. 1-2
FOR 240 VOLT CHART DRIVE	UPPER TERM. BLOCK, TERM. 1-4
HEATER	UPPER TERM. BLOCK, TERM. 7-8
R.H. MARKER PEN	UPPER TERM. BLOCK, TERM. 9-10

Fig. 7-8. External connections, 240-volt potential rating for element, Universal Wattmeter, 3-wire, 3-phase, without and with current transformers.*


240 V SOURCE
3 2 1
UPPER TERMINAL BLOCK
240V SOURCE
3 2 1
BACK VIEW
1 0 7 0 9 0 11 0
2 0 4 0 8 0 10 0 12 0
L
1 0 3 0 5 0 7 0 9 0 11 0
2 0 4 0 6 0 8 0 10 0 12 0
TO TERM. 8
TO TERM. 12
TO TERM. 5-9
LOWER TERM. BLOCK
LOWER TERMINAL BLOCK
LOAD
TRANSFORMER CONNECTIONS
LOAD

FOR 120 VOLTCHART DRIVE	UPPER TERM. BLOCK, TERM. 1-2
FOR 240 VOLT CHART DRIVE	UPPER TERM. BLOCK, TERM. 1-4

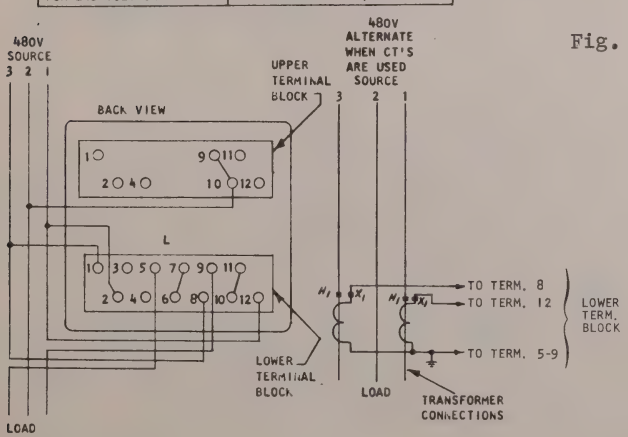

480V SOURCE
3 2 1
480V ALTERNATE WHEN CT'S ARE USED SOURCE
UPPER TERMINAL BLOCK
3 2 1
BACK VIEW
1 0 9 0 11 0
2 0 4 0 10 0 12 0
L
1 0 3 0 5 0 7 0 9 0 11 0
2 0 4 0 6 0 8 0 10 0 12 0
TO TERM. 8
TO TERM. 12
TO TERM. 5-9
LOWER TERM. BLOCK
LOWER TERMINAL BLOCK
LOAD
TRANSFORMER CONNECTIONS
LOAD

Fig. 7-9. External connections, 480-volt potential rating for element, Universal Wattmeter, 3-wire, 3-phase, without and with current transformers.*

*The connection diagram applying to your recorder may be cut out and pasted on the back of the recorder case.

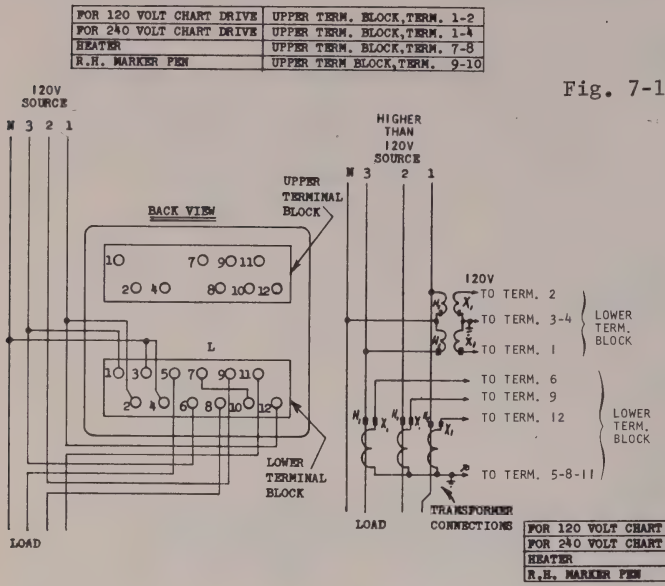


Fig. 7-10. External connections, 120-volt potential rating for element, Universal Wattmeter, 4-wire, 3-phase, without and with potential and current transformers.*

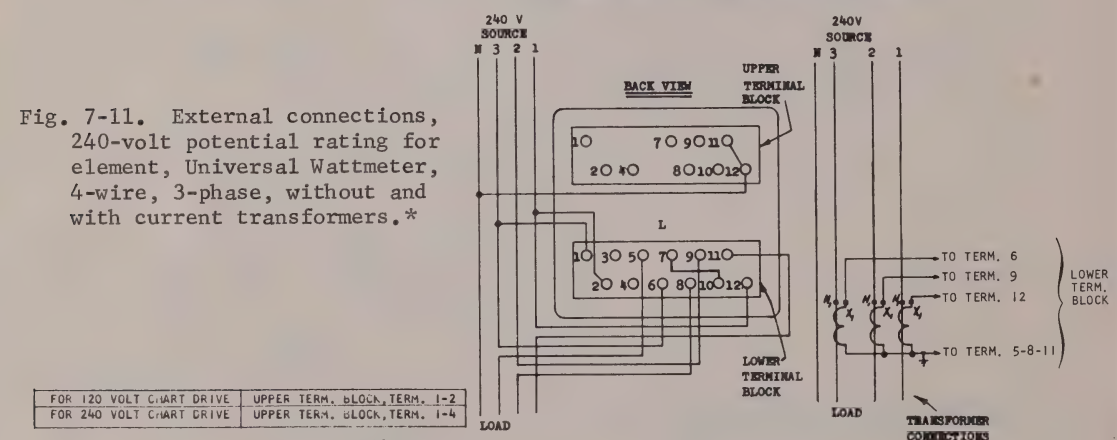


Fig. 7-11. External connections, 240-volt potential rating for element, Universal Wattmeter, 4-wire, 3-phase, without and with current transformers.*

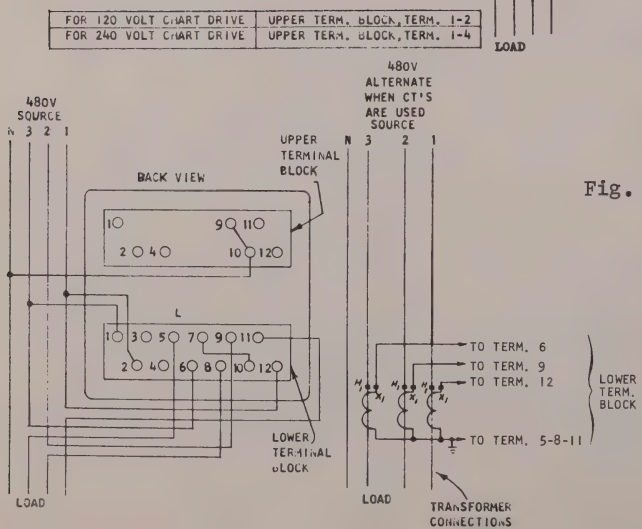


Fig. 7-12. External connections, 480-volt potential rating for element, Universal Wattmeter, 4-wire, 3-phase, without and with current transformers.*

*The connection diagram applying to your recorder may be cut out and pasted on the back of the recorder case.

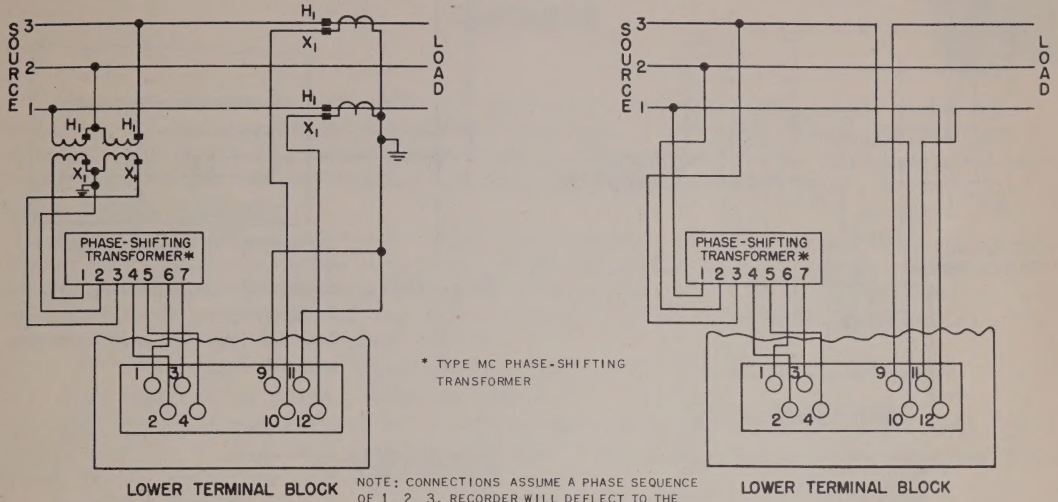

SOURCE
3
2
1
LOAD
H1
X1
PHASE-SHIFTING TRANSFORMER*
1 2 3 4 5 6 7
1 3 9 11
2 4 10 12
LOWER TERMINAL BLOCK
With current and potential transformers
* TYPE MC PHASE-SHIFTING TRANSFORMER
NOTE: CONNECTIONS ASSUME A PHASE SEQUENCE OF 1, 2, 3. RECORDER WILL DEFLECT TO THE RIGHT FOR VARS "OUT" (LAGGING POWER FACTOR) AND TO THE LEFT FOR VARS "IN" (LEADING POWER FACTOR). IF SEQUENCE IS ACTUALLY 1, 3, 2. REVERSE POTENTIAL CONNECTIONS 1 AND 3, AND 2, AND 4.
Self-contained

Fig. 7-13. External connections of 2-element varmeter or voltmeter, 3-wire, 3-phase* (Depending on phase-shifting transformer used.)

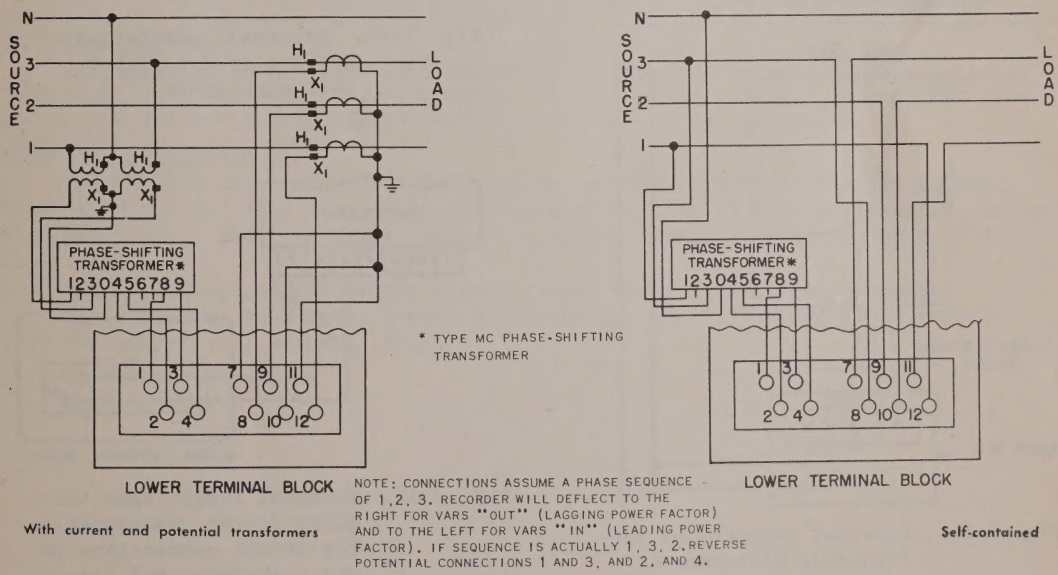
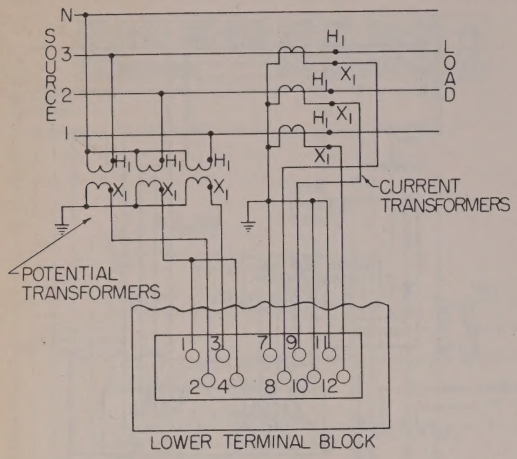

N
SOURCE
3
2
1
LOAD
H1
X1
PHASE-SHIFTING TRANSFORMER*
1 2 3 0 4 5 6 7 8 9
1 3 7 9 11
2 4 8 10 12
LOWER TERMINAL BLOCK
With current and potential transformers
* TYPE MC PHASE-SHIFTING TRANSFORMER
NOTE: CONNECTIONS ASSUME A PHASE SEQUENCE OF 1, 2, 3. RECORDER WILL DEFLECT TO THE RIGHT FOR VARS "OUT" (LAGGING POWER FACTOR) AND TO THE LEFT FOR VARS "IN" (LEADING POWER FACTOR). IF SEQUENCE IS ACTUALLY 1, 3, 2. REVERSE POTENTIAL CONNECTIONS 1 AND 3, AND 2, AND 4.
Self-contained

Fig. 7-14. External connections of 2 1/2 element varmeter or voltammeter, 4-wire, 3-phase* (Depending on phase-shifting transformer used.)

*The connection diagram applying to your recorder may be cut out and pasted on the back of the recorder case.



NOTE: CONNECTIONS ASSUME A PHASE SEQUENCE OF 1-2-3. INSTRUMENT WILL DEFLECT UPSCALE (TO THE RIGHT) FOR LEADING POWER FACTOR WHEN IT IS CONNECTED AS SHOWN. IF INSTRUMENT HAS SCALE FURNISHED FOR "IN-O-OUT", REVERSE POTENTIAL LEADS "3" AND "1" ALSO "2" AND "4".

Fig. 7-15. External connections of varmeter on 4-wire, 3-phase circuit with 3 potential transformers connected Y-Y.*

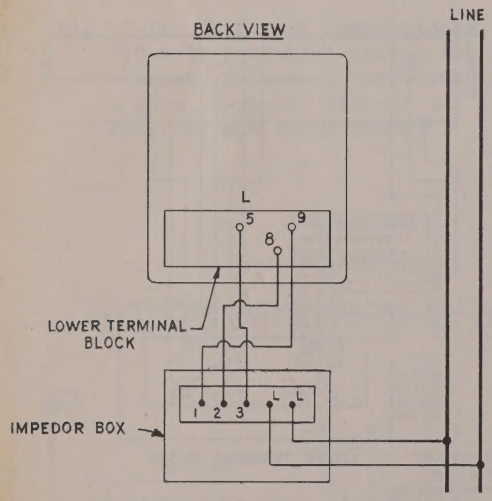


Fig. 7-16. External connections for frequency measurement using external impedor center tap DC Recorder*

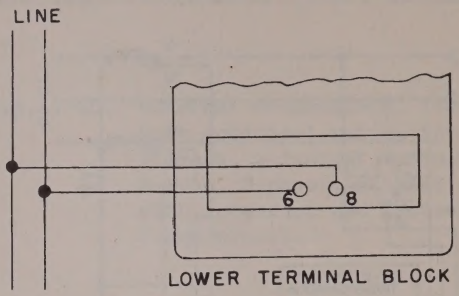


Fig. 7-17. External connections of frequency with self-contained impedor and center tap DC Recorder*

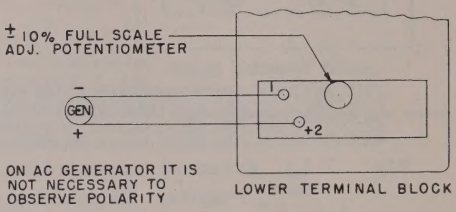


Fig. 7-18. External connections of rectified a-c or d-c tachometer generators

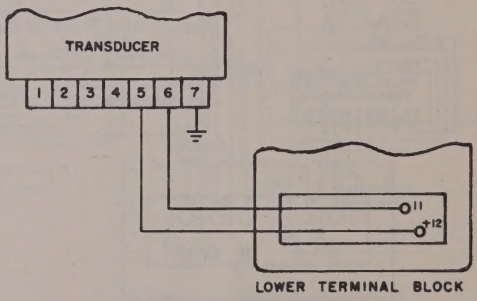


Fig. 7-19. External connections for power factor transducer. For detail connections to the transducer and line, see Transducer Instructions, 4544K12-001.

*The connection diagram applying to your recorder may be cut out and pasted on the back of the recorder case.

SECTION VIII
ADDENDUM

The information in this addendum applies to obsolete and special chart-carriage styles not covered in the forward sections of this publication. The chart carriage styles covered below are similar to the styles covered in the forward sections and most of the information applies, except as outlined below.

STYLE 3 CHART CARRIAGE

The Style 3 chart carriage, which is furnished only on special request, is a double-speed electric-drive unit which provides drives of both inches-per-hour and inches-per-minute in the range from 1/4 inch-per-hour to 120 inches-per-minute. A self-contained switch marked HI/OFF/LO is wired to provide inches-per-minute, off, and inches-per-hour chart-speed control.

For selecting and installing change gears, refer to recorder name plate.

For lubricating point, refer to Fig. 8-1.

For internal connections of a double-speed electric drive 120-drive unit, refer to Section V, Fig. 5-8. Note, that the resistor between the capacitor and drive motor is not there for the Style 3 chart carriage.

For internal connections of a 240-volt Style 3 chart carriage, refer to Fig. 8-3 of this section.

STYLE 4 CHART CARRIAGE

The Style 4 chart carriage is the same as the Style 3 chart carriage, except that this style contains provision for an external three-position switch. (The switch is not supplied.) A self-contained ON/OFF/ON switch is provided to activate the chart carriage.

For internal connections of a double-speed electric drive unit with external switching, refer to Section V, Fig. 5-9. Note that the resistor between the capacitor and drive motor is not there for the Style 4 chart carriage.

STYLE 5 CHART CARRIAGE

The Style 5 chart carriage, which is an obsolete style, is similar to the Style 25 chart carriage covered in the forward sections of this publication, except that the Style 5 chart carriage contains a 60-day clock unit instead of a 20-day clock unit.

For selecting and installing change gears, refer to recorder nameplate.

For reference to a Style 5 hand-wound spring clock with dust cover removed from the gear train, see Fig. 8-2.

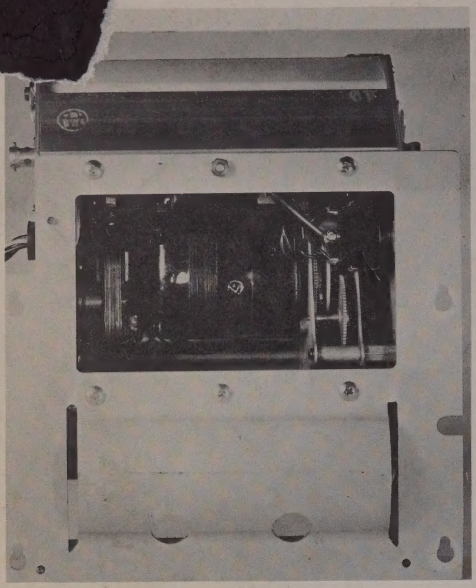


Fig. 8-1. Rear view of chart-carriage assembly (Style 3&4)

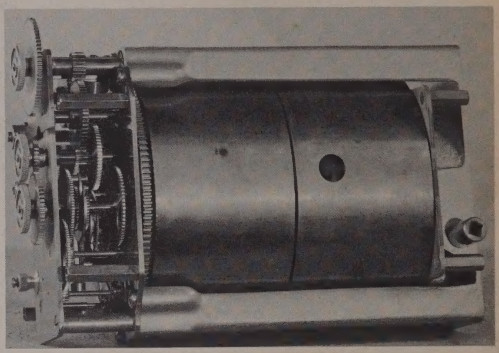
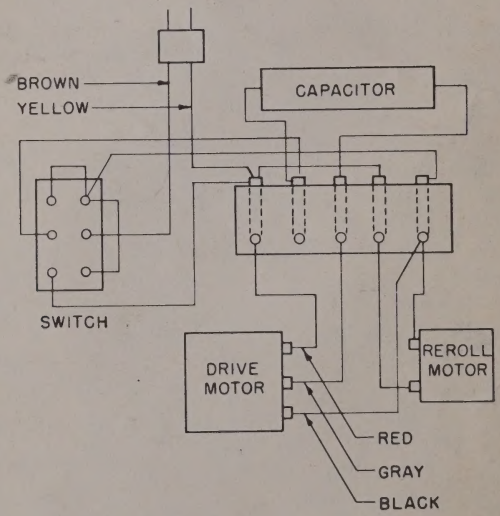


Fig. 8-2. Hand-wound spring clock with dust cover removed from gear train (Style 5)



DOUBLE SPEED ELECTRIC

Fig. 8-3. Wiring diagram for Style 3